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Edited by
Jenny L. Croker
Karen M. Vail
Roberto M. Pereira

Imported Fire Ant Conference 2000

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2000 Imported Fire Ant Conference Schedule

TIME	TITLE	AUTHOR(S) (PRESENTER IN BOLD), AFFILIATION(S)
April 5th		
4:00 - 6:00	Registration and Mixer	
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8:05 - 8:20	Dan Wheeler, Commissioner of Agriculture, TN	
8:20 - 8:30	Claude Ramsey, Hamilton County Executive	
8:30 - 9:00	Insights into the history of fire ant control	**D.F. Williams** USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology
9:00 - 9:30	Will the real *Solenopsis richteri* stand up!	**R.K. Vander Meer** CMAVE, ARS, USDA
9:30	Partners in crime: Imported fire ants and the rhodesgrass mealybug	**K,R** Helms & S.B. Vinson Texas A&M University
9:42	An ant-plant mutualism, can fire ants sour the relationship?	**J.A. Zettler,** C.R. Allen & T.P. Spira Clemson University
9:54	Impacts of fire frequency and red imported fire ants on native insects in a Louisiana longleaf pine savanna	**D.M. Colby** & D.P. Prowell Louisiana State University, Entomology Department
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10:30	Impact of red imported fire ant infestation on northern bobwhite quail abundance trends in Southeastern United States	**E. Myers**, C. Allen & M. Horton Clemson University
10:42	RIFA attack of quail eggs in the laboratory	**C. Calix** & L. Hooper-Bui Louisiana State University
10:54	The endangered Shaus swallowtail: Prey for the red imported fire ant	E.A. Forys, **A. Quistorff** & C.R. Allen Eckerd College, Clemson University, Clemson University
11:06	Effects of the red imported fire ant (RIFA) foraging on determination of post-mortem interval	**M.G. Colacicco** and W.K. Reeves Clemson University

11:18	Dietary habits of red imported fire ants in an Oklahoma peanut field	**J.T. Vogt** & R. Grantham Oklahoma State University, Department of Entomology and Plant Pathology
11:30	Red imported fire ant distribution and mound size under different cropping systems (2-Year Data)	**D.G. Manley** Clemson University
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12:00 – 1:00	Lunch	
1:00	Modeling habitat selection by *Solenopsis invicta*	**M.G. Colacicco**[1] and J.W. McCreadie[2] [1]Clemson University [2]University of South Alabama
1:12	A landscape perspective of fire ants (*Solenopsis invicta* Buren) and implications towards their management: an initial assessment	**S.T. O'Keefe**, R.M. Meegan, D.F. Wunneburger, A. Men, R.N. Coulson, & S.B. Vinson Texas A&M University
1:24	Landscape predictors of fire ant occurrence and spatial risk assessment of endangered species	**L. Parris**, C.R. Allen, P.M. Horton & E. Schmidt Clemson University; Dept of Entomology, Dept of Aquaculture, Fisheries and Wildlife, SC Cooperative Fish and Wildlife Research Unit, SC Dept of Nat Resources, Gap Analysis Program, USDA-ARS (Gainesville, Florida), U.S. Fish and Wildlife Service
1:36	Cold tolerance in imported fire ants	**S. James**, R. Pereira & K. Vail University of Tennessee, Department of Entomology and Plant Pathology
1:48	From nest-defender to scout: temporal sub-caste switching in *Solenopsis invicta*	**J. Martin** & S.B. Vinson Texas A&M University, Department of Entomology
2:00	Introduction of polygyne and monogyne newly mated fire ant queens into queenless colonies	**J.B. Anderson**, R.K. Vander Meer & L. Alonso USDA, ARS, CMAVE
2:12	Stridulation in the red imported fire ant, *Solenopsis invicta* (Buren)	**S.J. Rauth** & S.B. Vinson Texas A&M University
2:24	Multiple mechanisms induce dealation in *Solenopsis invicta* female alates	**S.N. Burns**[2], R.K. Vander Meer[1], P.E.A. Teal[1] & J.L. Nation[2] [1]CMAVE, ARS, USDA, Gainesville, FL; [2]Entomology Department, University of Florida, Gainesville, FL

2:36	Glands in the antennae of fire ant females.	**S.B. Vinson,** R. Renthal, D. Velasquez, N. Isidoro, R. Romani & F. Bin Dept. Entomology, Texas A&M; Div. Life Sciences, Univ. of Texas at San Antonio; and Dept. Arboricolture and Plant Protection, Perugia Univ. Italy
2:48	Queen dominance and the role of antennal glands in the dominance hierarchy of queens of polygynous colonies of the red imported fire ant (Hymenoptera: Formicidae)	**I. Kuriachan** & S.B. Vinson Texas A&M University
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3:30	Protein composition differences in antennal club, flagellum and scape of the red imported fire ant	**R. Renthal**, D. Velasquez & S. Hoog University of Texas at San Antonio
3:42	Contingent valuation of South Carolina households' willingness to pay for imported fire ant control	**S. Miller**, M. Henry, B. Vander Mey & M. Horton Clemson University
3:54	Fire ant education: Part of a county agent's responsibility	**K. Jones**, D. Shanklin & K. Loftin University of Arkansas Cooperative Extension Service
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8:24	Motivation of high school youth's interest in fire ant research	**D.B. Petty**, D.R. Shanklin & K.M. Loftin University of Arkansas Cooperative Extension Service

8:36	Progress report: The Texas Imported Fire Ant Research & Management Project	**B.M. Drees** Texas A&M University
8:48	Fire ant management program in a public housing project - Mount Pleasant, Texas	**C.L. Barr**, R.L. Best & R.G. McCarver Extension Program Specialist, Extension Assistant and Titus County Agent (respectively), Texas Agricultural Extension Service
9:00	A tale of two neighborhoods: examination of fire ant infestations before and after community-wide fire ant treatments in two San Antonio, Texas neighborhoods.	**N. Riggs** Texas Agricultural Extension Service, Bexar County, Texas
9:12	Community-wide fire ant management in Dallas and Tarrant Counties, Texas: an overview	**S.A. Russell** Texas Agricultural Extension Service
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9:36	The current status of the red imported fire ant control program in El Paso, TX	**W.P. Mackay**, D.I. Padilla, V. Treviso, M. Chavez, N.B. Hogue, I. Moreno, C. Morales, M.A. Mackay, L. Mackay, A. Enger, A. Hernando & H. Taylor Fire Ant Lab, Department of Biological Sciences, The University of Texas, El Paso
9:48	Area-wide bait treatments compared with individual homeowner treatments for red imported fire ant management	**L.M. Hooper-Bui**, A.M. Pranschke & H.M. Story Louisiana State University
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10:30	Phorid decapitating flies and fire ant biocontrol: past, present, and future research efforts	**S.D. Porter** USDA-ARS, CMAVE
10:42	I. Update on *Thelohania solenapsae* inoculation and infection studies. II. Sequential application of insect growth regulating and metabolic inhibiting fire ant baits	D.H. Oi & **D.F. Williams** USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology

10:54	The fire ant microsporidian pathogens, *Thelohania solenopsae* and *Varimorpha invictae*: field host range, intracolonial prevalence, and dual infections	**J.A. Briano**[1], D.F. Williams[2] and D.H. Oi[2] [1]USDA-ARS, South American Biological Control Laboratory, [2]USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology
11:06	The fire ant parasite *Solenopsis daguerrei*: progress report at the USDA-ARS-SABCL-Argentina	**J.A. Briano**[1], L.A. Calcaterra[1], D.F. Williams[2] and D.H. Oi[2] [1]USDA-ARS, South American Biological Control Laboratory, [2]USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology
11:18	Control of the red imported fire ant with hydrocarbon-consuming microbes	**W.D. Melvin** & R. Deslippe Texas Tech University, Department of Biological Science
11:30	Home-brewed fire ant control?	**J.T. Vogt**[1] and W.A. Smith[2] [1]Department of Entomology and Plant Pathology, Oklahoma State University [2]Oklahoma State University Cooperative Extension Service
11:42	A field comparison of five broadcast baits as full rate, hopper blend and skip-swath applications	**C.L. Barr**, Extension Program Specialist; R.L. Best, Extension Assistant; B.M. Drees, Professor and Coordinator Fire Ant Project Texas Fire Ant Project - TAEX
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1:12	Preliminary results of intranidal insecticidal bait treatments on the red imported fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae)	**D.I. Padilla**, N.B. Hogue & W.P. Mackay University of Texas at El Paso, Fire Ant Laboratory
1:24	Efficacy of broadcast and perimeter applications of S-methoprene for control of the red imported fire ant	**M. Aubuchon**, G. Mullen, M. Perdue Auburn University
1:36	Fire ant venom alkaloids as components of species specific baits	**S. Edwards-Bennett**[1], R.K. Vander Meer[1], S. Leclercq[2] & J.C. Braekman[1] [1]Laboratory of Medical and Veterinary Entomology Research-USDA [2]Laboratory of Bio-organic Chemistry, Faculty of Sciences-University of Brussels
1:48	Protecting young citrus from RIFA damage	**R. Patterson** University of Florida, Department of Entomology

2:00	Effects of fipronil treatments on non-target native ant species	**T. Davis**, M. Horton & L. Mudge Clemson Extension, Clemson University, Adventis
2:12	Quarantine treatments for nursery stock: a research update	**A.-M. Callcott** & H. Collins USDA, APHIS, PPQ, GPPS
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(NS = Not Submitted)

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INSIGHTS INTO THE HISTORY OF FIRE ANT CONTROL

David F. Williams
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Since its introduction into the United States over 70 years ago, the red imported fire ant, ***Solenopsis invicta,*** presently infests more than 310 million acres (126 million hectares) in thirteen states and Puerto Rico. The recent invasion of California could allow this pest the necessary foothold needed for the spread along the west coast of the U.S. This ant has had a substantial impact in the U.S. on humans, agriculture, wildlife and other organisms in the environment, and has caused damage to roads, electrical equipment, and telephone junction boxes.

The control of the fire ant has taken many twists and turns during the years since its first discovery with loads of advice given, numerous solutions recommended and many control techniques tried, however, it is still with us, expanding its range, and continuing to pose major problems. When fire ants were first discovered in 1929, their range was limited to the northern Mobile area and the small town of Spring Hill located nearby. In 2 years, they were discovered in other small communities and had spread to another county. Six years later, their populations had increased to levels of concern among the local people who demanded action from government agencies. Thus, the first organized control program for fire ants began in 1937 in Baldwin County, Alabama under the cooperative efforts of Federal, State and County agencies. Control consisted of opening a mound with a shovel, applying 1 to 3 oz (28 to 84 g) of 48% calcium cyanide dust into each mound and then covering up the opening with soil. With the outbreak of World War II, government control programs stopped but in 1948, control operations began again with the states of Mississippi and Alabama providing chlordane to farmers for fire ant control. In addition, the state of Louisiana funded the purchase of chlordane to farmers at cost and the state of Arkansas conducted an eradication project in 1957 in Union County and the city of El Dorado applying granular heptachlor by aircraft. In 1957, the U. S. Congress appropriated over two million dollars for a Federal-State cooperative project to use aerial and ground applications of granular heptachlor and dieldrin. Also, a Federal Quarantine was put in effect on all shipments of nursery plants, grass sod, sand, gravel and wood products with soil attached. Soon after the first treatments with heptachlor, mortality of wildlife began to occur and although rates were reduced several times, the growing concern with the effects on wildlife, intense criticism and pressure by many conservationists and some U.S. Congressmen to suspend the fire ant campaign was the beginning of the end of this program. Meanwhile, many fire ant researchers were well aware of the potential problems with large scale programs using chlorinated hydrocarbons and began development of baits for control at several laboratories in the South. Baits were thought to be far more environmentally acceptable than residual contact insecticides since only a very small amount of active ingredient is used in the formulation. In 1962, because of the low application rate and the apparent lack of harm to the environment, mirex bait became the standard treatment for fire ant control replacing heptachlor. Mirex bait was used from 1962 to 1978 and was applied to more than 140 million acres (56 million ha).

Because of the effectiveness of mirex and the low cost of application, the Southern Plant Board proposed to the USDA and Congress to expand an eradication effort. Because no research had been done on this, the Senate Agriculture Appropriations Subcommittee requested a study on the feasibility of an eradication effort and funded the USDA, ARS laboratory in Gainesville to determine if the use of mirex bait could totally eliminate fire ant from large areas. Control of the fire ant was excellent with 98-100% mortality of colonies in all treatments, however, even with this high rate of control over very large areas, reinfestation still occurred which increased doubt that mirex baits could be used to eradicate the fire ant. Meanwhile, scientists from the USDA and other institutions discovered that mirex residues not only persisted in the environment but accumulated in nontarget organisms and was very toxic to estuarine organisms. These studies revealed the detrimental aspects of mirex and the concerns of environmental damage. Court injunctions to stop its use were initiated in 1970 and after several years of hearings, all registrations of mirex was canceled by the EPA effective December 31, 1977. The cancellation of mirex left the public without any chemicals registered as baits for the control of fire ants. Southern constituents put pressure on Congress which resulted in intensified efforts by the USDA to find replacement chemicals for use as baits for fire ant control. After an accelerated screening program in the mid 1970's in which hundreds of compounds were evaluated, a new class of compounds, the amidinohydrazones, showed promise against cockroaches and imported fire ants. The most promising compound was AC 217,300 (hydramethylnon) and following excellent results in field evaluations, a conditional registration was approved August, 1980. It was formulated in a soybean oil-defatted corn grit bait called Amdro® and used against the fire ant on pastures, range grasses, lawns, turf and nonagricultural lands. During the 1980's, other chemicals were showing promise in laboratory and field tests. Some of these, such as fenoxycarb, abamectin and sulfluramid would eventually become available for use against fire ants and in the 1990's, registrations of pyriproxyfen, methroprene, and spinosyn also were approved for use as baits for fire ant control.

In the future, chemicals will probably be needed as one of the important tools for fire ant control. This is especially true for those areas considered as significant fire ant risk for humans such as school grounds, day-care nurseries, nursing homes, cemeteries, parks, sports facilities and other places where people frequently engage in outdoor activities. The high level of control and the speed with which chemicals can eliminate fire ant colonies may never be attained with biological organisms, consequently chemicals will be a necessary component of any integrated management program for these pests. However, the development of new technologies utilizing biological based strategies will be very important for the future management of fire ants. This includes more efficacious biological control agents and biopesticides, semiochemicals (pheromones) that disrupt colony organization, genetic and molecular manipulation of colony organization and reproduction, and the utilization of competitive ant species. In addition, the development of better physical methods of control and employing cultural methods could be very important in managing this pest. Finally, it will be necessary to use multiple control strategies with multi-state cooperation in order to coordinate and integrated a management system with a goal of reducing fire ant populations, contain range expansion, eliminating them from high risk areas where people work and play, and eradicate those isolated populations far removed from the major infestations of the U.S.

PARTNERS IN CRIME: IMPORTED FIRE ANTS AND THE RHODESGRASS MEALYBUG

Ken R. Helms & S. Bradleigh Vinson
Department of Entomology, Texas A&M University, College Station, TX 77843-2475

We have discovered that the red imported fire ant, ***Solenopsis invicta***, builds shelters for a variety of honeydew producing Homoptera. Most shelters are inconspicuous, built at ground level around the base of plants, and are integrated into the underground tunnel system. Homoptera shelters occurred on a diversity of plants, primarily native grasses. High density of shelters and Homoptera tended suggests that the Homoptera may be a major food source for imported fire ant colonies. In our study, most Homoptera in shelters were mealybugs (Pseudococcidae), although aphids also occurred. A majority of mealybugs in shelters were the rhodesgrass mealybug, ***Antonina graminis***. ***Antonina graminis*** is a cosmopolitan pest of grasses in tropical and subtropical regions of the world. The mealybug is of uncertain origin, and was probably introduced into the United States around 1900. In the United States, the distribution of ***Antonina graminis*** appears very similar to the distribution of the imported fire ant, suggesting that the mealybug could be an important factor in imported fire ant invasion, establishment, and persistence.

IMPACT OF RED IMPORTED FIRE ANT INFESTATION ON NORTHERN BOBWHITE QUAIL ABUNDANCE TRENDS IN SOUTHEASTERN UNITED STATES

E. Myers, C. Allen & M. Horton

Northern bobwhite quail (Colinus virginianus L.) populations are declining throughout their range. One factor contributing to the decline in the southeastern United States may be the red imported fire ant (Solenopsis invicta Buren). Recent research in Texas has documented that red imported fire ants can have a significant impact on northern bobwhite quail. That research was conducted in areas where fire ants are predominately polygynous (multiple queen). Polygynous infestations have much higher mound densities than the monogynous (single queen) form. In most of the southeastern United States, fire ants are predominately monogynous. We determined if there was a relationship between the invasion of monogynous red imported fire ants and abundance trends in northern bobwhite quail in the southeastern United States. For Florida, Georgia, and South Carolina we compared average northern bobwhite quail abundance based on Christmas Bird Count data for each county before and after fire ant invasion, and conducted regression analyses on bobwhite quail abundance and year preinvasion, and abundance and year postinvasion. Regionally, northern bobwhite quail were more abundant before (0.067 ± 0.018 bobwhite quail per observer hour) than after fire ants invaded (0.019 ± 0.006; $\underline{Z} = -3.746$, df = 18, $\underline{P} < 0.001$). There was no significant regional population trend for northern bobwhite quail ($\underline{r}^2 = 0.24$; df = 9, $\underline{P} = 0.13$) before fire ant invasion. Post-invasion, northern bobwhite quail populations significantly declined regionally ($\underline{r}^2 = 0.76$, df = 15, $\underline{P} < 0.001$), and in Florida ($\underline{r}^2 = 0.71$, df = 15, $\underline{P} < 0.01$) and South Carolina ($\underline{r}^2 = 0.50$, df = 9, $\underline{P} = 0.01$). The number of years that a county had been infested by fire ants explained 75% of the yearly variation in northern bobwhite quail abundance after invasion, despite >30 yr variation in invasion dates.

RED IMPORTED FIRE ANT ATTACK OF QUAIL EGGS IN TEE LABORATORY

L.C. Calix & L. M. Hooper-Bui. Department of Entomology, Louisiana State University

Red imported fire ants, ***Solenopsis invicta*** **Buren**, attack different species of eggs of ground or box nesting species including reptiles and wild bird eggs (Allen et al. 1994). Reports have shown fire ants to attack wild bird eggs such as wood ducks (Sikes & Arnold **1986),** Attwater's prairie chicken, northern bobwhite quail, and scissor-tailed flycatcher (Wilson & **Silvy** 1988). Stoddard (1931) & Travis (1938) first reported fire ants as a source of quail egg mortality. Now there is controversy about the attack of fire ants on hatching and incubating quail eggs. Dewberry (1962) reported that incubating birds were undisturbed by fire ants, but he also reported that 12% of hatching quail eggs were destroyed by fire ants. **Simpson** (1976) observed that out of 1725 quail nests in Georgia, fire ants destroyed only 1 nest.

This experiment is an initial effort to provide more information about red imported fire ant attack on quail eggs in the laboratory. Our objective was to determine if there is a diierence in attack of breached or unbreached eggs. We also wanted to determine if colony hunger was associated with attack.

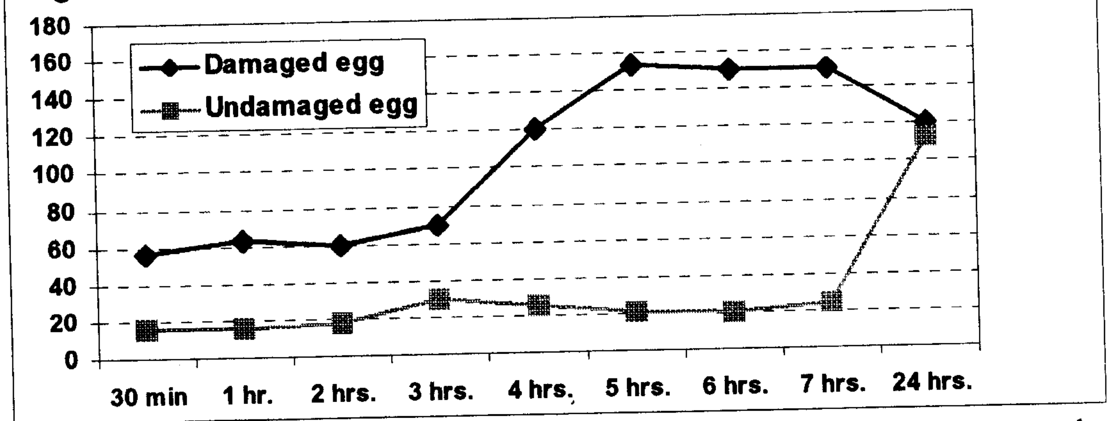
Materials and Methods

Three starved and three satiated fire ant colonies were each offered a binary choice test with damaged and undamaged quail eggs. Eggs were damaged by punching them with a pencil to try to simulate an initial breach made by hatching birds (called pipping). Prior to the experiment, colonies were starved for 48 h during which they were only provided water. Eggs were weighed before exposure to colonies and again at 24 h. Number of ants attacking the eggs were observed and counted hourly during the first 8 h and at 24 h.

Results and Discussion

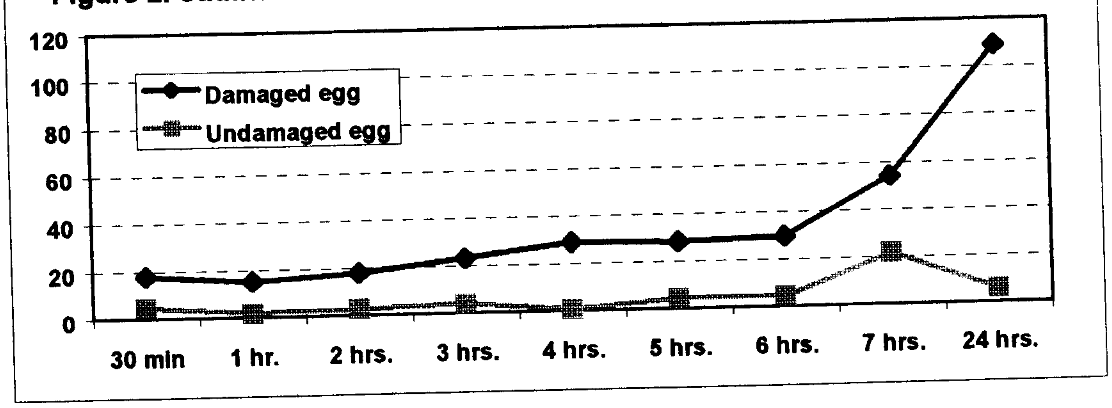
Starved colonies had a higher number on fire ants attacking quail eggs when compared to satiated colonies. Fire ants attacked both damaged and undamaged eggs almost immediately after they were placed in the colony and the number of ants on the eggs **increased** through time (Figure 1), reaching their peak after 5 h on damaged eggs and after 24 h on undamaged eggs. When given a choice, undamaged eggs were less attractive to fire ants, with lower number of ants attacking them compared to **damaged** eggs. After 24 h, ants removed an average of 2.4 g with the damaged egg weight reduced **from** 10.3 g to 7.9 g active feeding on the proteinateous contents. No weight changes were observed on undamaged eggs.

Figure 1. Starved fire ant colonies attack to *Cotornix cotornix* eggs.



Ants in satiated colonies attacked eggs almost immediately after they were placed in the colony, showing a preference for the damaged eggs, although the total number of ants on all eggs were lower than those of the starved colony. Also, the number of ants on damaged and undamaged eggs increased through time (Figure 2), reaching their peaks after 24 and 7 hours respectively. No weight changes were observed on damaged or undamaged eggs. Ants in satiated colonies did not feed on eggs contents of damaged eggs.

Figure 2. Satiated fire ant colonies attack to *Cotornix cotornix* eggs.



These data suggest the presence of fire ants on damaged eggs is independent of the level of hunger in the colony. However, ants from starved colonies actively fed on the contents of eggs, while ants from satiated colonies did not feed. Fire ant presence on eggs does not always indicate active feeding, especially in satiated colonies. Differences in ant predation of breached eggs in the field maybe a function of nearby ant colonies' hunger. Bird nests near large unsatiated ant colonies will be at greater risk than those near satiated colonies. It may be possible to predict, based on food availability, where ant suppression efforts should be concentrated to protect ground nesting or box nesting vertebrates. Future studies will be conducted under natural conditions to provide more data on the fire ant feeding behavior on quail eggs.

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THE ENDANGERED SCHAUS *SWALLOWTAIL (PAPILIO ARISTODEMUS PONCEANUS)*: *PREY FOR THE* RED IMPORTED FIRE ANT

Forys, Elizabeth A.[1], Anna Quistorff[2], and Craig R. Allen[2]. [1]Natural Sciences Collegium, Eckerd College, 4200 54th Ave. S., St. Petersburg, FL 33711; and [2]U.S. Geological Survey, Biological Resources Division, South Carolina Cooperative Fish and Wildlife Research Unit, Clemson University, Clemson, SC 29634.

The Schaus Swallowtail, ***Papilio*** (Heraclides) ***aristodemus ponceanus***, is a large dark brown and yellow butterfly that historically occurred in hardwood hammocks ranging from South Miami to the upper Florida Keys. Much of the remaining hardwood hammock habitat is badly fragmented by roads and human development that may alter the microhabitat within the hammocks and increase the probability of invasion by non-native predators and competitors. The Schaus Swallowtail is currently listed as federally endangered and one invasive non-native species that may have an impact on the Schaus is the predaceous red imported fire ant ***(Solenopsis invicta* Buren)**. We estimated abundance of red imported fire ants in Schaus swallowtail habitat and the potential to decrease red imported fire ants through chemical ant baits. In addition, we conducted laboratory experiments to determine how vulnerable swallowtail life stages are to red imported fire ant predation. We found red imported fire ants at 50% of transects in the hardwood hammock and at up to 40m from the edge of the hammock. Chemical treatments were only mildly effective at decreasing red imported fire ant abundance. All swallowtail life stages were vulnerable to predation by red imported fire ants, 100% of the eggs, larvae, and pupae were consumed. Because of the vulnerability of the swallowtail life stages to predation and the ineffectiveness of the chemical treatments, habitat restoration that decreases red imported fire ant abundance may be the most cost-effective method of decreasing the potential impact from red imported fire ants.

EFFECT OF RED IMPORTED FIRE ANT (RIFA) FORAGING ON DETERMINATION OF POST-MORTEM INTERVAL (PMI)

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Law enforcement frequently uses the insects that are present on a body and stage of decomposition to help establish post-mortem interval (PMI) in homicide investigations. High densities of red imported fire ants **(RIFA)** near a body may alter the arthropod succession or the time that it takes for a body to reach different stages of decomposition. The goal of this research is to determine if foraging by **RIFA** has an effect on carcass decomposition.

This study was conducted in February and March 2000. Four field sites were located in the area of Clemson, South Carolina. **RIFA** foraging activity was determined by placing multiple-species ant attractant (MSAA) baits every 15m throughout each field site. Six chickens were randomly placed at each site and secured in wire cages. After two weeks, 3 chickens were randomly selected from each site for removal. Representatives of all insects present on each of these chickens were preserved. Maggots from each carcass were reared to adulthood for identification. Four weeks after initial placement, the remaining chickens were removed from the field sites. Insects were collected as previously described. Once all chickens were removed, PMI was determined for each and ANOVA was conducted across sites to determine if there was a difference in PMI estimate based on **RIFA** foraging.

RED IMPORTED FIRE ANT DISTRIBUTION AND MOUND SIZE UNDER DIFFERENT CROPPING SYSTEMS (2-YEAR DATA)

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The red imported fire ant, ***Solenopsis invicta*** **Buren**, may build large mounds which can present a problem to growers. When farm machinery hits large mounds, considerable damage may result. Although it is known that soil type, cultivation, and vegetative cover influence both mound size and distribution, few specifics are known. It is the objective of this study to show what influences different cropping practices may have on fire ant distribution and mound size. A fourteen acre field on the Pee Dee Research and Education Center was split roughly down the middle. One half has been farmed using conventional cropping practices (varieties, row spacing, tillage, fertilizer, etc.), the other with more innovative practices (including narrow row spacing and minimum tillage). The entire field was planted in corn in the spring of 1998. After harvest, the corn was followed by soybeans. Shortly after soybean planting (June 1998), baseline fire ant infestations in the field were nine mounds/acre in the conventional side, and five moundslacre in the innovative side. After soybean harvest (October 1998), there were 18 mounds/acre in the conventional side, and 44 moundslacre in the innovative side. This represents 2x and 9x increases, respectively. All mounds were mapped on both occasions using GPS technology.

The procedure was repeated in the Spring of 1999, after planting corn. At that time, the numbers of mounds per acre were 49 in the conventional, and 37 in the innovative. Mounds were once again flagged, counted, and mapped on 7 October 1999, following corn harvest. At that time, the numbers of moundslacre were seven and 39, respectively. While numbers on the innovative side had remained about the same, numbers on the conventional side had decreased by about 9x. Cultivation and relatively wide row spacing, along with hot, dry weather, drastically reduced mound numbers on the conventional side of the field in 1999.

Will plant cotton spring 2000 & continue project.
(Warren Busher? (USDA) looking at mound size.

MODELING HABITAT SELECTION BY *SOLENOPSIS INVICTA*

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Research Summary

The goal of this research is to create a predictive model of Red Imported Fire Ant (RIFA) habitat selection in South Carolina grasslands. Ultimately, this model will be used to help predict RIFA population levels in a given area and improve pest management. This model will be particularly useful in areas, such as cattle pastures, where heavy application of chemicals is ill advised.

In May and June 1999, 15 sites were sampled throughout South Carolina. Five sites were located in the Piedmont, four in the Sandhills, and six in the Coastal Plains. Five sites were located on pastures, eight on hay fields, and two on other fields. Independent variables measured at each site were soil chemistry, soil type, vegetative cover, soil moisture, soil temperature, ecoregion in which the site was located, and land use. The dependent variables were RIFA foraging, number of other ants foraging, mound density, mound height, and mound volume.

Analysis of variance was used to determine whether ecoregion, soil type, and land use significantly affect the dependent variables. Significantly greater numbers of RIFA foraged on sandy soil than on fine loam soil (Table 1). Mound height and volume in the Coastal Plains were higher than in the Sandhills and Piedmont (Tables 2 and 3). Land use and mound density were not related to any of the dependent variables.

Principal components analysis (PCA) was used to examine the variables for soil chemistry (pH, buffer pH, Na, Ca, Mg, and K), soil temperature, soil moisture, and percent vegetative groundcover. The independent variables were condensed into three statistically independent principle components (PC), accounting for 79.3% of the variance. PC1 was composed of pH, Ca, and Mg and accounts for 39.8% of the variance. PC2, representing soil temperature, accounts for 25.3% of the variance. Potassium content of the soil was reflected by PC3, which represents 14.2% of the variance. Once the principle components were identified, stepwise multiple regression was performed (Table 4) to identify any significant relationships between the dependent variables and the PCs. Mound height and volume were significantly associated with PC2 (soil temperature); however, none of the principle components were associated with RIFA foraging and mound density.

A second field season will be conducted in May and June 2000. Twenty-five new sites during the second field season. The sites will again be equally distributed through the three major ecoregions of the state. Additional variables will be examined in 2000: vegetation height, vegetation type, air temperature, relative humidity, and total precipitation for six months prior to sampling. The inclusion of more habitat variables will help further elucidate those factors that influence RIFA population levels.

Table 1. ANOVA of RIFA foraging over soil type.

Soil Type	Mean Log (RIFA + 1)	F (2,11)	p
Sandy	1.53 a	5.98	0.017
Coarse Loam	1.20 ab		
Fine Loam	0.48 b		

Table 2. ANOVA of mound height over ecoregion.

Ecoregion	Mean Mound Height (cm)	F (2,12)	p
Piedmont	4.99 a	4.06	0.045
Sandhills	5.31 a		
Coastal Plain	11.79 b		

Table 3. ANOVA of mound volume over ecoregion.

Ecoregion	Mean Mound Volume (cm^3)	F (2,12)	p
Piedmont	13885 a	4.36	0.038
Sandhills	21212 a		
Coastal Plain	72037 b		

Table 4. Results of stepwise regression

Dependent Variable	Regression Model	P value	R^2 value
RIFA foraging	---	> 0.05	---
Other Ants Foraging	0.253 + 0.138 pc2	0.033	30.4
Mound density	---	>0.05	---
Hound height	7.80 – 2.16 pc2	0.016	37.2
Mound Volume	39099 – 16404 pc2	0.026	35.2

A LANDSCAPE PERSPECTIVE OF FIRE ANTS (SOLENOPSIS *INVICTA* BUREN) AND IMPLICATIONS TOWARDS THEIR MANAGEMENT: AN INITIAL ASSESSMENT

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Red imported fire ants (RIFA) (Solenopsis invicta Buren) occur throughout the landscape in the post-oak savanna ecoregion of Texas. However, the density of their mounds and choice of foraging areas are not evenly distributed over the different habitat types or even within any given habitat. A spatially referenced study at a landscape scale was undertaken to assess areas of RIFA dominance as a basis for a hazard rating system for RIFA in the post-oak savanna. This primary study was based on surveys of mound densities throughout a 625 acre study site conducted in 1998 and 1999. Two supplemental studies included comparing the foraging activity and relative species richness of ants across ecotones and measuring the fluctuation of RIFA mound densities throughout the seasons.

To develop a hazard-rating map of RIFA in the post-oak savanna, sample points distributed randomly across the landscape were collected on three occasions. Focusing on the May 1999 and August 1999 collections, two factors, land cover type and patch size, were considered in landscape patch analysis of mound densities. Grassland, dense woodland and cleared woodland land cover types dominate the landscape. Dense woodlands are relatively unmanaged areas and contrast to cleared woodlands in terms degree of recent soil disturbance. Significant differences for mound densities were discovered in the May 1999 sample when land cover type and patch size interaction was considered. For grassland and dense woodland, large patches tend to have higher RIFA mound densities than small patches. However, for cleared woodlands, mound densities decrease in large patches. In Aug 1999, no significant interaction between these two factors was discovered. Although mound densities decreased substantially in August 1999, densities for grassland and cleared wood indicated trends similar with May 1999. However, for dense woodlands, mound density did not significantly change with respect to patch size.

For the ecotone study, the seven most common ecotones selected were: wood-grass, wood-pond, wood-cleared wood, wood-cultivated field, grass-pond, cleared wood-pond, and cleared wood-grass. A total of 227 pitfall traps were arranged along 63 transects and activated for seven days in the fall, 1998, and early summer, 1999. The RIFA and 16 genera of native ants were found among the seven ecotone types. The wood-grass ecotone was the most diverse, with all 17 ant genera represented. The RIFA, composing between 49% and 94% of the total ants found for each ecotone, was significantly greater in abundance than all native ants combined in all seven ecotones. RIFA abundance was the most significant within the grass-pond and wood-cultivated field ecotones.

In order to measure the fluctuation of mound density throughout the seasons, mound densities were surveyed at 30 different points at seven times in 1998 and 1999 in a single large grassland patch. There was a statistically significant decrease in the total number of active mounds during late summer in both years. However, when only large (over 30 cm dia.) active mounds were counted, no statistically significant differences were found within each year, but statistically significant differences were found between 1998 and 1999.

Results of the research pose several implications to landscape management. Developing hazard ratings for landscapes with the consideration that densities of RIFA mounds vary by particular land cover type, precision targeting can be employed so that controls are prioritized to areas of higher expected concentration; thereby limiting environmental impact and economic cost of controls. Because densities are affected by temporal as well as spatial variables, control applications can be timed to provide the most impact on RIFA populations. In addition, because late summer mound densities normally decrease, post-application surveys conducted in August will show a bias toward successful control. Finally, landscape designers and managers may be able to affect RIFA populations by manipulating the distribution of ecotone interfaces between specific patch types.

The Texas Fire Ant Research and Management Plan provided funding for research.

COLD TOLERANCE IN IMPORTED FIRE ANTS

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In the past, it was theorized that imported fire ants could not maintain infestations north of the -12°C minimum isotherm. However, imported fire ants now infest areas north of the -12°C minimum isotherm, and continue to slowly expand their range northward. There is some geographical segregation of the fire ant species as the red imported fire ant occupies most of the southern states, the black imported fire ant occupies the northern border of the fire ant range, and the red-black hybrid cuts a band of territory between the two. There has been speculation on the possibility of hybrid vigor increasing cold hardiness, which is expected to be an important factor in the survival and control of these ants within the northern boundaries.

Our objective was to assess the effects of species, size, and infection with the biocontrol ***Thelohania solenopsae*** on the cold hardiness of imported fire ants. These ants do not display freeze-tolerance; therefore, cold hardiness may be based on ability to acclimate to cooler temperatures and depress their supercooling point. The supercooling point is recorded as the lowest temperature reached before freezing, and a heat spike that results from the release of latent energy when the insect freezes. Supercooling points were recorded for individual large and small workers of ***Solenopsis richteri, S. invicta, S. richteri x invicta*** hybrid, and ***Thelohania*** infected S. ***invicta.*** Five colonies of each group were selected and within those colonies ten large and ten small workers were tested. The ants were attached to either a 0.1mm or 0.01mm diameter thermocouple and placed in a freezer. Data were recorded by a Campbell Scientific CR10 datalogger and viewed through use of the accompanying software. S. ***richteri*** and hybrid colonies were collected from Tennessee; *S.* ***invicta*** colonies used were from Florida

There was additional concern about colony time spent in lab prior to testing due to supercooling point discrepancies in previous literature. We examined this in *S.* ***richteri*** and hybrid colonies by testing supercooling points within the first week after field collection of ants and retesting three months later. The *S.* ***invicta*** colonies were tested a month after their original field collection date and thus were not included in this comparison. Testing on new S. ***invicta*** colonies is currently underway.

Our results found that time spent in the lab prior to testing significantly affected the supercooling point of imported fire ants. Variation among colonies of the same species increased after three months in the lab. Large S. ***richteri*** and hybrid workers displayed a decrease in supercooling ability while small ants showed an increase in supercooling ability after being in the laboratory for three months. Due to the significance of holding time effect on the supercooling point, the results for the ***S. invicta*** were not compared with those for the ***S. richteri*** and hybrid ***ants.*** The ***Thelohania-infected*** *S.* ***invicta*** did display a colder supercooling point than uninfected S. ***invicta*** in both small and large workers. The lower supercooling point of the ***Thelohania***-infected *S.* ***invicta*** may be a concern for use of this biocontrol in the northern region of the imported fire ant range. S. ***richteri*** workers supercooled at lower temperatures than the hybrid workers within the same size class and test time. While more testing is needed, a lower supercooling point appears to be a factor for range occupation by imported fire ant species.

FROM NEST-DEFENDER TO SCOUT: TEMPORAL SUB-CASTE SWITCHING IN *SOLENOPSIS INVICTA*

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One important characteristic of red imported fire ant (Solenopsis invicta Buren) societies is their large colony size. Workers, without centralized control, organize themselves to accomplish tasks needed by the colony as a whole. How workers order themselves to accomplish the various labor needs required by the colony is central to understanding the organization of insect societies (Wilson 1978). In ants in general there is at least a weak correlation between the age of the worker and the type of task in which she is engaged (Bourke and Franks 1995). Temporal or centrifugal polytheism is believed to be the process by which ants change tasks; as time goes on an ant is more inclined to become involved with tasks that take her from the center of the colony towards the periphery, and ultimately, out to forage (Bourke and Franks 1995). This process is also influenced by the current nutritional status of the nest and social stimuli (Traniello 1989). The ability of *S.* invicta to dominate habitats is, in part, probably due to the behavioral flexibility that large numbers of reserve workers allows them.

Our objective was to quantify the rate that ants move from reserve status to forager status under two nutritional regimes. This study was conducted over a 42 day period in February and March, 2000. Four mature monogyne fire ant colonies were dripped and weighed, and had a mass of at least 70 grams (queen, brood, and workers). Arenas were prepared for each (dimensions: 6.5 x 1 m). The substrate of each arena was sand covered to a depth of 4 cm. A wooden nest-box (65 x 45 x 10 cm) filled with a combination of top soil and clay was placed in the center of each arena. Because of the favorable micro-climate in these nest-boxes, the majority of the fire ant colonies (queen, brood, alates and workers), established there. Steel walls were erected inside of the arenas, subdividing them into 11 patches. The nest boxes were placed in the center patch, the remaining patches simulating remote foraging patches that were connected to the colony area by glass tubes. Feeding stations were established near the nest-box, where the ants were fed artificial diet (hamburger meat, sugar, salt, multi-vitamins, gelatin, and water), crickets, and carbohydrate (10 % sucrose solution). For the first 34 days of the study each colony was fed as much as it could process. The last eight days of the study each colony=s food was cut by one half.

We chose a mass marking technique, using Testors[7] paints and airbrush, modified from the technique of Bhatkar et al. (1991). Paper was placed at the top of the colony nest-boxes prior to disturbing the colonies by tapping the nest-box. Those workers that emerged were marked with a fine mist of paint. We took a digital image of the ants on the paper at the moment of painting, thus giving us a strong estimate of the number of workers marked. Those ants that responded to the disturbance represent a group of ants that are, at the moment of marking at least, a cohort of reserves responding to a particular task (alarm behavior) in a similar manner. We painted the ants on five separate occasions (each with a unique color), eight days apart.

Every 48 hours we removed all ants (both live and dead) from the foraging patches, keeping live ants separate from the dead ones. Ants were examined at 15 x magnification for paint marks, and all ants were tabulated.

The results, which will be discussed in detail at the conference, consists of numbers of scouts in patches vs. numbers of reserves marked, for sated and partially fed treatments, over time. These data will predict the number of reserve ants that advance to scout status under the well-fed and partially fed treatments, and allow for comparisons between them.

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GLANDS IN THE ANTENNAE OF FIRE ANT FEMALES

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Glands are described from the antennae of both worker and queen Imported Fire Ants, ***Solenopsis invicta*** Buren. This is the first description of glands in female aculate hymenoptera. Both SEM and TEM show the presence of type III glands (Noirot and Quennedey, 1991). These ectodermal glands are found on A9 of the workers and A9 and A10 of the queens. The ducts leading from the gland cells to the antennal surface exit through pores present on the glabrous region of the gland segment. Although the pores are more numerous on the dorsal surface, they form a ring around the antennal segment. Frequently, a paste-like secretion can be seen emerging from the pores of queens.

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QUEEN DOMINANCE AND THE ROLE OF ANTENNAL GLANDS IN THE DOMINANCE HIERARCHY OF QUEENS OF POLYGYNOUS COLONIES OF THE RED IMPORTED FIRE ANT (HYMENOPTERA: FORMICIDAE)

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The queens in polygynous colonies of the red imported fire ant ***(Solenopsis invicta* Buren)** differ in their reproductive output and in their attractiveness to workers. When separated, the queens can be ranked as a dominant queen and subordinate queens according to their worker attractiveness. We initiated a study to determine the potential advantage of aggregation and to determine the effect of queen dominance on the body weight, egg production and survival of subordinate queens. The results showed that aggregation is beneficial for both dominant and subordinate queens; however, the subordinate queens benefited more. In order to determine the role of antennal glands in the dominance hierarchy of the queens, we conducted a study by amputating the apical two or three antennal segments from both antennae and from one antenna of the dominant and subordinate queens. The removal of clubs from both antennae resulted in mortality of the queens, regardless of their status in the dominance hierarchy. The removal of antennomeres 10 and 11 from both antennae of the dominant queen resulted in her losing the status as the most attractive queen. and some mortality The amputation of one club had no significant effect upon the queens. These results confirm that the antennal glands have important an function in the contact behavior among colony members. change in dominance?

Subordinate queen dependent on dominant queen for fitness, nutrition .... ?

PROTEIN COMPOSITION DIFFERENCES IN ANTENNAL CLUB, FLAGELLUM AND SCAPE OF THE RED IMPORTED FIRE ANT

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Previous studies of antenna morphology in red imported fire ants (RIFA) indicated sexual and caste differences [1]. In order to understand the functional significance of these differences for communication and colony behavior, we have analyzed the protein composition of male and worker antennae, and also compared the protein composition of individual worker antennal segments.

RIFA antenna morphology is summarized in figure 1. The male antenna lacks the long scape (segment A1) and lacks the enlarged club (distal segments) found in female antennae. The male also lacks basiconic sensilla and has many more coeloconic sensilla. Queens have an additional segment in the club compared to workers. Segment A9 in workers and segments A9 and A10 in queens have secretory glands that are unique to Solenopsis [2].

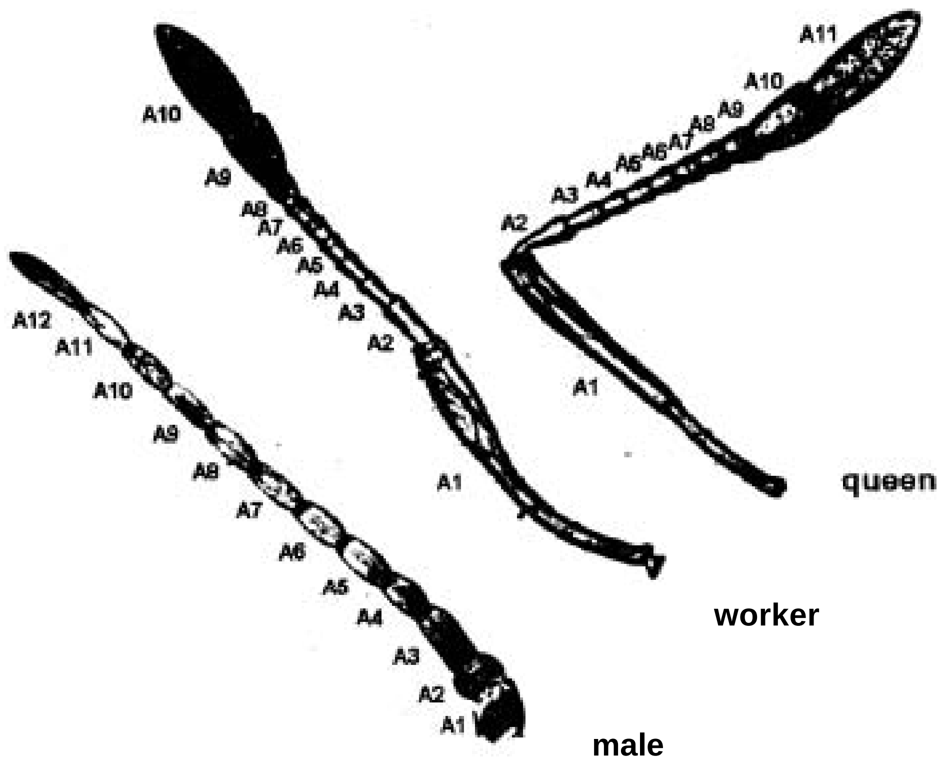

Figure 1: RIFA antenna segments

Proteins in RIFA antenna were analyzed by SDS polyacrylamide gel electrophoresis (figure 2). Two hundred worker antennae were dissected (ants were from polygyne lab colonies, collected in North Bexar County, Texas). Segments A1, A2-A8, A9, and A10 were gathered into separate pools. Each pool was transferred to a small mortar and ground with a pestle in 40 µL of sample buffer (62.5 mM tris, pH 6.8; 2 % SDS, 20% glycerol). The homogenized tissue, combined with an additional 20 µL wash of sample buffer, was briefly centrifuged and then applied to a 12% polyacrylamide gel [3]. After electrophoresis, the gels were stained with coomassie blue.

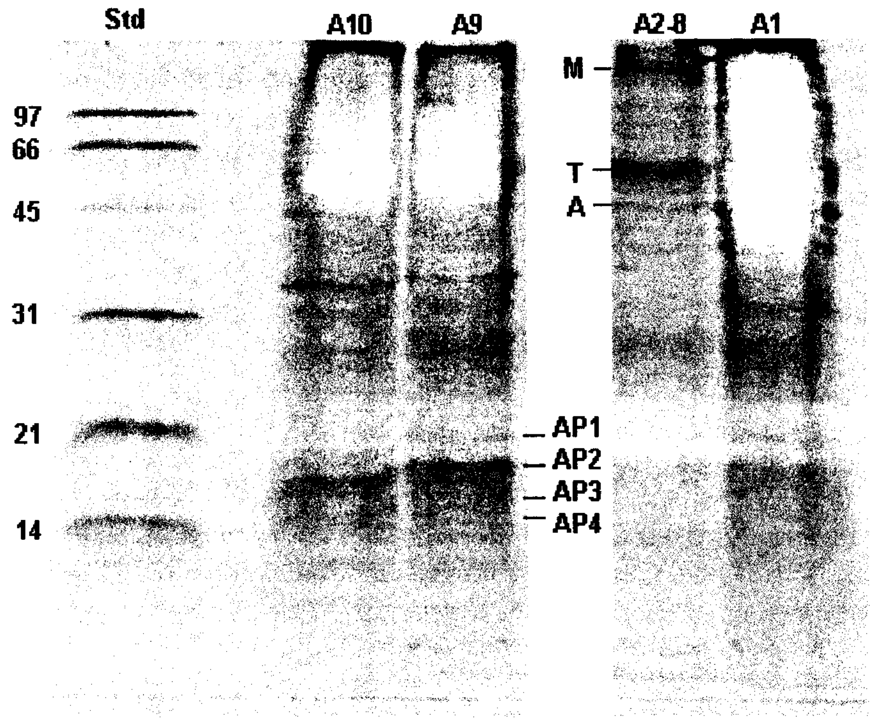

Figure 2. SDS-PAGE analysis of antennal proteins. Std=molecular weight markers (molecular weights in KD), A10 and A9 are club segments, A2-8 is the flagellum minus the club, and A1 is the scape. Proteins AP1-3 are present in both segments A9 and A10. AP4 appears only in A9. Likely identifications of other proteins, based on size: M=myosin, T=tubulin, A=actin.

Protein differences can be seen between the segments. The club segments (A9 and A10) have much larger amounts of proteins less than 20,000 molecular weight (marked AP1 - AP4). The non-club part of the flagellum (A2-A8) has far less protein than the other segments. The scape (A1) is rich in bands near the molecular weights of actin and myosin, consistent with the muscle fibers that are apparent in this segment when viewed by light microscopy. Analysis of the male antenna shows two prominent low molecular weight proteins corresponding to AP1-2. Antenna proteins from whole worker antennae were separated by electrophoresis as in fig. 2 and then electrophoretically transferred to polyvinylidine difluoride film [4]. After staining with coomassie blue, AP-1 and AP2 were cut from the film and N-terminal protein sequence analysis was performed in an ABS gas-phase protein sequencer. The resulting sequences indicate that AP1 and AP2 are similar to known odorant-binding proteins from other insects. This is consistent with our previous electron microscopic studies showing that most porous sensilla in the RIFA antenna are on the club segments.

A difference in protein composition between the two club segments may be significant for the function of the glands in segment A9. This segment appears to have an additional low molecular weight protein (AP4). Since the sensilla types are similar between A9 and A10, it is possible that protein AP4 is a component of the gland secretion.

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CONTINGENT VALUATION OF SOUTH CAROLINA HOUSEHOLDS' WILLINGNESS TO PAY FOR IMPORTED FIRE ANT CONTROL

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The imported fire ant (IFA) first appeared in South Carolina (SC) in 1952, and has since spread to each of SC's 46 counties. Households in SC and other southern states are impacted adversely by the IFA in several ways. First, the IFA poses a health threat, as it is aggressive and has a venomous sting. Second, household members may have to forgo outdoor leisure activities in order to avoid IFA stings. Third, households incur costs in treating and/or preventing IFA infestations and repairing IFA damage in and around their residences. Although households benefit from public programs that improve IFA control, these programs incur costs, and so the benefits of IFA control should be weighed against the program costs. The IFA can be thought of as a form of environmental pollution, so approaches used by economists to assess the benefits of environmental improvements (e.g., improved air or water quality) can be adapted to measure the benefits of IFA control. Contingent valuation (CV) is one such approach. People are asked how much they would be willing to pay for an environmental improvement if they were able to purchase the improvement in a market. Summing the individuals' willingness to pay (WTP) responses gives an estimate of the aggregate benefits of the environmental improvement (Mitchell and Carson). Alternatively, under certain conditions the averting cost savings (ACS) approach provides an estimate of the lower bound of WTP for an environmental improvement by measuring individuals' expenditures to avert or defend against the pollution effects (Bartik). A public program that improves the environment would result in a savings of these expenditures.

Previous studies have provided estimates of the household benefits and/or cost savings from improved IFA control. Lemke and Kissam asked visitors to IFA information booths at various SC public gatherings how much they would be willing to pay per year for IFA control. The median response for 430 individuals was $10.01 to $30. Diffie et al. surveyed visitors to a IFA information booth at an agricultural exposition in Georgia and employees of an agricultural experiment station in southern Georgia. The mean of the household IFA-related expenditures from the pooled samples (320 respondents) was $35 per year. Thompson et al. surveyed households in three counties in southern Arkansas, using Cooperative Extension Service mailing lists. Based on a sample of 325 households, they estimated mean annual IFA-related costs of $87 for urban households, defined as households with less than 1 acre or less of land; and $298 for rural households, defined as households with more than 1 acre of land.[2] Salin et al. conducted an area-frame survey of households in five metropolitan areas in Texas. The mean annual household PA-related expenditure was $151 and the mean CV response for IFA control was $89/household. In Miller et al., we used data fiom a survey of SC households to estimate benefits to SC's

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[2] The costs for rural households included IFA damage to crops and livestock.

household sector of IFA control by the ACS approach. In this paper, we use the SC survey data to estimate those benefits by the CV approach and provide comparisons to the benefits estimated by the ACS approach.

Materials and Methods

A random sample of SC households was contacted by telephone between November 1998 and January 1999. The survey instrument solicited information on households' experiences with the IFA, their expenditures on IFA control and remediation, their willingness to pay for IFA control, and their socio-economic characteristics.

Respondents were asked if it was important to them to control the IFA. Those who answered "Yes" were then asked how much they would be willing to spend each year for control. The response categories were \$0, \$1-10, \$11-20, \$21-30, \$31-40, \$41-50, \$51-100, \$101-200, \$201-300, \$301-500, \$501-1,000 and \$1,001 or a higher specified amount. The contingent valuation measure of the WTP by the ith household, CV_i, was assigned as follows:

CV_i = \$0 if IFA control was not important to the respondent, or if IFA control was important to the respondent and he/she selected the \$0 response category, or if IFA control was important to the respondent but he/she was either unable or unwilling to select a response category;

= mid-range of the selected category if the respondent selected a category from \$1-10 to \$501-1,000,

= \$1,001 if the respondent either selected this amount or was unwilling to list a specific higher amount; and

= specified amount greater than \$1,001.

The participants were also asked to list the cash expenses they incur, by category (treatment, electrical repair, other repair, medical, and pet veterinary), for IFA control and remediation in an average year. The expenditure categories for the ith household were summed to obtain the household's potential cost savings from IFA control, ACS_i.

About one-half of the sample values of CV and ACS equal \$0. Application of ordinary least squares (OLS) in estimation of models explaining CV and ACS would be inappropriate because the OLS estimators are biased regardless of whether all values or only positive values of the dependent variable (CV or ACS) are used in estimation. Tobit estimation was used to overcome this problem (Greene, pp. 962-966).

Results and Discussion

Out of a random sample of 861 household representatives reached by telephone, 809 agreed to participate in the survey.[3] Of the 809 households, 46% had positive CV values and 52% had positive ACS values. The estimated mean annual CV, \$86 per

[3] Based on data for the SC population from the 1990 Census (U. S. Bureau of the Census, 1992), middle and high income, white and married households who live in their own homes are over-represented in the sample. On average, the heads of the respondent households are older than household heads in the SC population, and they have a higher level of educational attainment than adults in the population. The characteristics of the sample households are typical for telephone survey research. Women are more likely to answer the phone at home and are more likely to agree to participate in surveys than are men. Whites tend to be more comfortable than other races in participating in telephone survey research. Also, participation rates in telephone surveys tend to be higher for individuals with higher levels of education and income (Babbie).

household (standard error = SE = \$8/household) is greater than the estimated mean ACS, \$80 per household (SE = \$9/household), but the null hypothesis that the mean CV equals the mean ACS cannot be rejected at conventional levels (paired t-value = 0.57). According to the U. S. Bureau of the Census (1998), there were an estimated 1.376 million households in SC in 1996, the latest year for which population estimates are reported. Based on the sample means, the estimated annual benefits that would accrue to SC's household sector from IFA control equal \$118 million when the benefits are estimated by the CV approach and \$110 million when the benefits are estimated by the ACS approach.

In order to examine the factors that may affect CV and ACS values across households, we estimated Tobit models in which CV and ACS were alternatively specified as the dependent variable. Various household characteristics were used as independent variables, including: age of the household head; number of household members; and dummy variables for household annual income (<\$20,000, \$20,000 - \$50,000, > \$50,000), educational attainment of the household head (high school or less, or at least some college or technical school), gender of the household head (male or female), race of the household head (white or non-white), residence location (North West, North Central, West Central, Central, Eastern, or Southern region),[4] residence ownership (owned or rented), residence type (detached or other), and residence lot size (none, smaller than 1 acre, 1 acre or larger). Most of the explanatory variables had coefficients that were not significant at reasonable levels and were dropped from the models.

The Tobit estimation results are shown in Table 1. Because of missing values for one or more of the independent variables (mainly for the household income variables), only 532 observations were available for estimation. Looking first at the CV model, the estimated constant applies to a "base" household located outside the North West region that has a residential lot smaller than 1 acre, a white head, and an annual income of less than \$20,000. Each of the estimated coefficients for the independent variables in the CV model is significant at or below the 10% level.

Based on data for SC households from the 1990 Census (U. S. Bureau of the Census, 1992), 27% are non-white, 28% live in the North West region, 40% have middle incomes (\$20,000 to \$50,000 per year), and 32% have high incomes (more than \$50,000 per year). Using these data and assuming that the percentages of sampled households without residential lots, 6%, and with residential lots of 1 acre and larger, 39%, are representative of the state's population, the independent variables in the Tobit model have the following values for the "average" SC household: NW = 0.28, NOLOT = 0.06, BIGLOT = 0.39, RACE = 0.27, MIDI = 0.40, and HIGHI = 0.32. The predicted probability that CV is greater than \$0 for the "average" household is:

$$1-\Phi\left(\frac{-(-123.83-157.20*0.28-290.01*0.06+124.25*0.39-80.91*0.27+86.31*0.40+127.86*032}{319.00}\right)$$

$=1-\Phi\left(\frac{-(-83.20)}{319.00}\right)=1-\Phi(0.26) = 1 - 0.60 = 0.40$, where Φ denotes the standard normal distribution function. The predicted CV value for the "average" household is:

[4] The regions correspond to the crop reporting districts of the South Carolina Agricultural Statistics Service.

$(1-\Phi(0.26))*(-83.2)+319*\phi(0.26)=0.40*(-83.2)+319*0.39=\$90$, where ϕ denotes the standard normal density function. Relative to the unconditional estimates, the Tobit model indicates the average household has a lower predicted probability of a positive CV value, 0.40 versus 0.46, but a higher predicted CV value, $90 versus $86.

The estimated coefficients in the ACS model have the same signs as the corresponding coefficients in the CV model except for the estimated coefficient for MIDI; however, this coefficient has a low absolute t-value ($|t| = 0.44$). Only the estimated coefficients for NW and NOLOT are significant at conventional levels. Dropping MIDI from the ACS model has minimal effects on the point estimates of the other coefficients, the estimated coefficients for NW, NOLOT, and HIGHI are significant at the 1% level, and the absolute t-values for the BIGLOT and RACE coefficients are greater than one. The following discussion focuses on the ACS model in which the coefficient for MIDI is restricted to zero.[5] For the "average" household, the predicted probability that ACS is positive, 0.42, is less than the corresponding unconditional estimate, 0.52. However, the estimated conditional mean value of ACS for the "average" household, $118, is larger than the unconditional estimate of that mean, $80. For the "average" household, the predicted value of ACS is higher than the predicted CV value.

The effects of a change in an individual independent variable on the predicted probabilities that the CV and ACS values are positive and the predicted CV and ACS values depend on the levels of the other independent variables. Table 2 summarizes the effects of changes in the independent variables for the "average" household. In general, residential lot size and location have the largest percentage effects on the expected CV and ACS values. Having a residential lot of less than 1 acre in size increases the expected CV value five-fold and the expected ACS values more than seven-fold relative to not having a residential lot, all else constant. An increase in residential lot size from less than 1 acre to more than 1 acre increases the expected CV value by 70%, but the expected ACS values increase by less than 20%. Household location outside the North West doubles the expected CV value and nearly triples the expected ACS values relative to a North West location. An increase in household annual income from less than $20,000 to $20,000 - $50,000 increases the expected CV value by 49%. Increasing household annual income to more than $50,000 results in a 19% increase in the expected CV value and a 44% increase in the expected value of ASC. A household with a white head has expected CV and ACS values that are respectively 44% and 24% higher than the corresponding expected values for a household with a non-white head.

Also shown in Table 2 are the extremes of the expected CV and ACS values. For a household located in the North West region with no residential lot, a non-white head, and an annual income of $20,000 or less, the predicted probabilities that the CV and ACS values are positive equal 0.02, and the expected CV and ACS values are $3 or lower. On the other hand, for a household located outside the North West region with a residential lot of 1 acre or larger, a white head, and an annual income of more that $50,000, the pre-

[5] When the coefficient for MIDI is restricted to zero, the estimated constant applies to the "base" household located outside the North West region that has a residential lot smaller than 1 acre, a white head, and an annual income of $50,000 or less.

dicted probabilities of positive CV and ACS values are 0.63 or higher, and the expected CV ACS values are $202 or higher.

Both the CV and ACS approaches are capable of measuring households' WTP for IFA control, albeit with error. The mean CV and ACS values are similar, giving us additional confidence in stating that substantial benefits would accrue to SC households from the development and implementation of public programs that would improve IFA control. Furthermore, the Tobit model results indicate that the CV and ACS values are affected by a common set of household characteristics. We caution against extrapolating our results to other states in which the IFA is established. Although the IFA was reported as established in each SC county as of the time of our survey, the Tobit model results indicate there are significant differences in the CV and ACS values across regions in SC. We suspect households' WTP for IFA control may differ across regions within other states as well. Additional survey research is needed to obtain valid assessments of the potential benefits of IFA control in those states.

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Table 1. Tobit Models Explaining Contingent Valuation of IFA Control and Annual Cash Expenditures on IFA Control and Remediation by SC Households (n = 532).[a]

Independent Variable	Dependent Variable		
	CV	ACS	
constant	-123.83**[c]	5.77	-15.97
NW	-157.20***	-272.59***	-272.65***
NOLOT	-290.01***	-446.45***	-439.62***
BIGLOT	124.25***	45.07	45.80
RACE	-80.91*	-64.65	-59.92
MIDI	86.31*	-26.32	
HIGHI	127.86**	83.86	104.65***
sigma	319.00	391.49	391.65
Pseudo-R^2	0.16	0.16	0.16

[a] Dependent variables are CV = contingent valuation ($/year/household) and ACS = cash expense ($/year/household). Independent variables are: NW = 1 if the household is located in the North West region, 0 otherwise; NOLOT = 1 if the household residence does not have a lot, 0 otherwise; BIGLOT if the household lot is 1 acre or larger, 0 otherwise; RACE = 1 if the household head is non-white, 0 otherwise; MIDI = 1 if the household annual income is $20,000 to $50,000, 0 otherwise; and HIGHI = 1 if the household annual income is greater than $50,000, 0 otherwise.

Table 2. Predicted Values of Contingent Valuation of IFA Control and Annual Cash Expenditures on IFA Control and Remediation for Selected Household Characteristics.[a]

Predicted Probability of Positive Value		Predicted Value (dollars)		Household Characteristic					
CV	ACS	CV	ACS	NW	NOLOT	BIGLOT	RACE	MIDI	HIGHI
0.40	0.42	90	118	0.28	0.06	0.39	0.27	0.40	0.32
0.45	0.49	109	153	0	0.06	0.39	0.27	0.40	0.32
0.27	0.24	53	55	1	0.06	0.39	0.27	0.40	0.32
0.36	0.42	78	122	0.28	0	0	0.27	0.40	0.32
0.10	0.09	16	17	0.28	1	0	0.27	0.40	0.32
0.51	0.47	132	142	0.28	0	1	0.27	0.40	0.32
0.42	0.43	99	125	0.28	0.06	0.39	0	0.40	0.32
0.33	0.37	69	101	0.28	0.06	0.39	1	0.40	0.32
0.31	0.38	63	105	0.28	0.06	0.39	0.27	0	0
0.41	0.38	95	105	0.28	0.06	0.39	0.27	1	0
0.46	0.49	113	150	0.28	0.06	0.39	0.27	0	1
0.02	0.02	2	3	1	1	0	1	0	0
0.66	0.63	202	233	0	0	1	0	0	1

[a] See Table 1 notes for definitions of CV, ACS, and household characteristics.

FIRE ANT EDUCATION: PART OF A COUNTY AGENT'S RESPONSIBILITY

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Fire Ant Education is part of a county agent's responsibility. In Grant County, Arkansas, a predominantly rural county of 16,000 people, 31 miles southeast of Little Rock, fire ants are one of many problems. Fire ants are a problem throughout the county, and impact a majority of residents. Integrating fire ant education into the overall county program is possible because so many residents are impacted by the red imported fire ant.

INTEGRATION

Our Extension County Councils direct much of the programming. In Grant Co., they identified fire ants as one of the topics they wanted the county program to address. Based on phone calls to the county office fire ants are a definite concern. The phone calls helped to identify the areas where education was needed. Many people were using home remedies such as gasoline, and grits. Some people were using the correct products, just incorrectly.

The following is an overview of how fire ant education was integrated into the county's Extension Program:

INFORMATIONAL MEETINGS

Informational meetings have been conducted in many of the Grant Co. communities. Presentations at the local Rotary Clubs, and Cattlemen's are important also. The meetings address many of the questions local residents have about fire ant biology, and more importantly control options. The phone calls received help in programming many of the meeting, i.e., the meetings address many of the fallacies of fire ant control. Arkansas' success and failures in the neighborhood abatement process are generally included in those meetings.

GRANT COUNTY YOUTH

Youth are impacted by fire ants. Fortunately the Arkansas Extension Service has developed a coloring book and youth oriented video. The materials provide a ready-made program that enforces any presentation made at a school or youth program. Using fire ants as an example, youth are also introduced to entomology and ecosystem type concepts. In a "youth at risk" program youth selected fire ants as the subject for an informational booth at the county fair. Conducting programs with youth also helps in determining what is really being used to treat fire ants. An informal survey conducted in 1998 prior to an educational program found that more than 80% of the youth had parents that were using gasoline, or a derivative thereof, to treat fire ants.

HOMEOWNERS AND NEIGHBORHOODS

Homeowners often call the extension office for information on how to start an abatement program in their neighborhood. We inform them that we will assist them in organizing and we will train them in proper pesticide application. However, we cannot organize, treat, and maintain the abatement area. Gray Oaks and Pine Crest are two examples. Gray Oaks is a subdivision of approximately 25 houses. It was selected as a demonstration site for the neighborhood abatement process in the Spring of 1998. We assisted them in by providing product, and the manpower to put the product out in both the spring and fall. We also evaluated the impact of the treatments periodically. In early spring of 1999 neighborhood members were contacted and ask to organize on their own the program. They elected NOT to continue the abatement process – because 'we don't have any ants now'. We learned a lesson from that experience. You can control fire ants just a little too well. Pinecrest was another neighborhood program initiated in Spring 1999. Residents were NOT provided products, but paid up front for products purchased. They were also involved in the actual application process. We assisted by conducting the evaluations. Control of the fire ants was not achieved in that there was a small field near the neighborhood that was a source for re infestation. That area has been recognized and will be treated along with the subdivision. The neighborhood plans to continue the program in 2000.

COUNTY POLITICS

Local politics play a role in the fire ant education and demonstration areas. We often treat areas that our County Judge or other local politicians frequent. We do this for several reasons — but primarily because they are leaders in the community and if we can educate them about the proper methods of control, they will definitely educate others. In Grant Co. the most visible locations for fire ant demonstrations are the county courthouse, the local recreation facility, and the county fairgrounds. Prior to a high profile education effort many of these areas were highly infested with fire ants. However, demonstrations in all these locations have made TWO STEP proponents out of many of our county leaders. County participation is emphasized at all sites.

CATTLEMEN and POULTRY PRODUCERS

Cattlemen are the most difficult group to talk about fire ants, because we really have few viable options for them. Pesticides are too costly, and options such as dragging the fields are not used. We have managed to get them excited about many of the biological control options available and they are often the strongest proponents of this method of fire ant management. Poultry production is a relatively small venture in Grant Co., but fire ants have found the broiler houses. We have found that educating producers in management options related to fire ants is quite easy since they are receptive to new ideas. They especially like the fact that when they pick up dead chickens they aren't covered in fire ants.

NEWSPAPER ARTICLES

Use of the local newspaper is important in most extension offices. The Grant Co. office is a small office of only two agents – an agriculture agent and family and a consumer science agent. As such, the local newspaper helps in getting pertinent information out to the general public. However, regarding fire ants they often like to go for the sensational. We are constantly reminding the newspaper that fire ants cannot be eradicated, and that reading and following the label instruction is an important part of a story. Promotion of the Fire Ant Awareness Month is a great way that we have found to introduce fire ant information. The Extension Services' Communication Section releases several articles and radio bits to coincide with many public meetings we conduct in April. It definitely makes our job easier.

CONCLUSION

Development of a fire ant educational program in a county can be quite successful. People see positive results and a diverse group of people are impacted. A successful fire ant program can lead to a successful livestock program, 4-H club, or forage demonstration.

The overall goal for the fire ant education program in Grant Co. is educating people on what we refer to as the 3 C's. Correct Product. Correct Timing. Correct Application. To achieve this goal, we will need to increase the visibility of all aspects of extension education. Many people are still not aware that the information we provide is FREE and available to all. People need to be constantly reminded that fire ant control is not an overnight solution – it takes weeks for control and it isn't a permanent solution.

ARKANSAS CITY: A CASE STUDY IN COMMUNITY SPIRIT

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The red imported fire ant (Solenopsis invicta) is a pest insect that has been reeking havoc on homeowners, cattlemen, businesses, churches, as well as parks and recreational areas. These pesky insects are diminishing people quality of life, due to their fiery sting and attraction to electrical conduits. In Arkansas, the Cooperative Extension Service attempts to address people's concerns about fire ants through education. Part of the education process involves informing people about the management options. The fire ant's presence can be minimized through proper use of pesticides. A Community-wide Fire Ant Abatement program is one of the options, and is defined as the reduction in the degree of intensity of fire ants. However, community involvement is key to having a successful abatement program. We have found that once people are educated about the management options, and the community is receptive to working together, the Extension Service can help them to organize and impact fire ant presence in their community.

We have made a case study of one such example -- Arkansas City. Arkansas City is a small community of approximately 500 people located in the Delta region of southeast Arkansas. We have separated this case study into three steps: step one education, step two action, step three evaluation.

STEP ONE EDUCATION:

An Arkansas' Extension Agent's responsibility includes working with their county councils. These councils are members of the community who relate to the agent the community's concerns for extension programs. In recent years the Desha County extension council has identified fire ants as a community concern. To address their needs, a fire ant education process was implemented in Desha County.

An education meeting was set up with various community leaders throughout the county to educate them about the fire ant management options available to them in June of 1998. The agent and fire ant educators met with county officials in to discuss fire ants and the potential for abatement programs in Desha Co. Those in attendance included Mayors and Chamber of Commerce members in the county as well as the County Judge. A brief presentation on the options available to them regarding fire ant management was made, and community-wide abatement was given as an option. The Extension staff was up-front in that their role is education and that the ownership of a Fire Ant Abatement Program would be the individual community's or a city's. The people in attendance were interested in abatement of the fire ants. The initiative did not move forward because no one present was willing to take leadership of a program.

However, that is the not the end of the Desha Co. fire ant program. Many programs in Extension complement another. In Arkansas we have a very successful Master Gardener Training program. Part of the curriculum in Jefferson County is fire ant education. A Desha County resident from Arkansas City, Helen Linn attended Master Gardener training and really became passionate about starting an abatement program in her community. After being educated about fire ants and the abatement process she became determined to begin a Fire Ant Abatement program in Arkansas City.

STEP TWO - ACTION:

Before a fire ant abatement program can be initiated a community or an individual has to be willing to organize and work together. To begin the process Mrs. Linn -- as a member of the Arkansas City Chamber of Commerce --- invited Agriculture Agent Rebecca Watson to speak at the March Chamber meeting. After an educational slide presentation was given on fire ants and the abatement program, many Arkansas City residents were ready to take ownership of **their** abatement program. At this first meeting many volunteered to be Block Coordinators. Two additional block coordinator meetings were conducted. The Block Coordinators were in charge of contacting residents. An informative letter was written and distributed to the entire community through these individuals. The Block Coordinators collected money and made contacts with residents to explain the program. Watson also spoke to the Arkansas City - City Council for their support.

To further reduce costs of the program the county agent Watson contacted Timberland Industry of Monticello, Arkansas to obtain Amdro® for $6.76 per pound, and a HERD® spreader was provided to the community by the Extension Service. The total cost per city block treated was $40 for both applications. On average each application per household cost $5.

The Two-Step method was used in the abatement program. The First Step, which is a broadcast application of a bait product was used. Amdro® was the product used at 1 lb. per acre. The first treatment was made in late May to early June. The Second Step, which consists of treating individual problem mounds seven to 10 days after baits have been applied was used also. Residents treated mounds themselves with Orthene® provided by Mayor Bixler. A second broadcast treatment of Amdro® was made in September.

The agent was notified of only one negative comment about the abatement program. A resident believed that the product had killed 20 of her ducks. After researching the LD 50 of the product, it was found that the lethal dose of Amdro for waterfowl was 1 pound of product per 3 pounds of duck. Less than one pound was applied to the resident's yard. It was then determined that the Amdro was not the cause of the ducks death.

A follow-up meeting was conducted in December. The Block Coordinators met at a Chamber of Commerce meeting. The success of the program was reviewed and suggestions were made to make the program in the year 2000 more successful. Their suggestions included treating the levee as well as the City, and to have residents pay for both treatments at the beginning of the program.

STEP THREE EVALUATION:

Evaluating why the program was successful in Arkansas City while many fire ant abatement programs never start or fail was important. Many factors made this program in Arkansas City a very successful one. The primary factor is the presence of Mrs. Linn in the community. This community proved that it takes one very determined citizen to get the begin the organizational process and make a program work. Mrs. Linn's enthusiasm was very contagious. The second factor was that the local government was very supportive, i.e., they bought into the program. Arkansas City Mayor Jim Bixler supplied personnel to make the product applications, as well as provided product for the individual mound treatments. The third factor was that the ENTIRE community bought into the program and were very pleased with **their** program. Many local leaders had to be 'won over', but with the enthusiasm of the community behind the program it was not difficult. The Extension Service had a role in the successs also. The county agent was educated and comfortable talking about fire ant management options, and was there at a community level to answer any questions.

Our Conclusions:

The Abatement program is a success when the community becomes involved. It took one "spark" in the community to make it happen. And that spark was Helen Linn. Other community leaders became interested and the entire community took ownership of the program. Watson and Linn have spoken in other communities in the county, and there appears to be interest in developing their own abatement programs.

From an Extension level it is very gratifying to agents to watch the knowledge that they give to a community make such an impact on so many lives. The beauty of the Arkansas City Fire Ant Abatement Program is that we did our job as educators and the community did their job and implemented what was taught.

WHITE COUNTY FIRE ANT EDUCATIONAL PROGRAM LEADS TO AREA-WIDE TREATMENT AND A PRO-ACTIVE STAND IN BEEBE, ARKANSAS

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Abstract

Red Imported Fire Ants were first discovered in White County, Arkansas in 1996. Since the initial find, isolated imported fire ant populations have occurred in several other areas of the county including a large infestation in Beebe. Because of the IFA occurrence in the county, the Cooperative Extension service launched an intensive fire ant educational program that included control demonstrations, public meeting, meeting with public officials, and local media outlets. Success of this program has resulted in a pro-active approach to fire ant management including the first large-scale organized abatement program in a NON-QUARANTINED county in Arkansas.

Introduction

White County, Arkansas is located in East Central Arkansas on the northern boundary of the Federal Imported Fire Ant Quarantine in Arkansas. In the spring of 1996 red imported fire ants were first discovered in a flower bed in the city of Beebe in southwest White County. Since the initial discovery isolated imported fire ant populations have been found in several other areas of the county.

Red imported fire ants were reported next in the fall of 1997 at a residence three miles north of Bald Knob in northeast White County. In the summer of 1998 red imported fire ants were reported in the city of Searcy on the White County Fairgrounds and later on in several other areas of the city. Infestations in Searcy were alarming since Searcy, with a population of 18,000 and located in central White County, is the county seat and financial hub of White County. The latest report of fire ants was in the fall of 1999 at a newly constructed senior citizens home in the city of Pangburn located in north-central White County. All of these reports had the common origin of landscaping materials.

The first demonstration conducted in the county was at the White County Fairgrounds in Searcy in August of 1998. A sense of urgency existed for the demonstration, since the County Fair was only a month away. The Extension Service (White County Extension Agents and Extension Fire Ant Specialist) worked closely to educate the Fair Board on the importance of treating and the economic impact and liability that fire ants could have for the fair. The fairground's 80 acres was broadcast treated on August 24, 1998 with Amdro® (0.73% hydramethylnon) at 1 lb. per acre. Talstar® (bifenthrin) was used as a follow-up for drench treatments and perimeter spray around buildings.

A second demonstration was conducted at the site north of Bald Knob with a broadcast bait treatment of Award™ (fenoxycarb) at 1 lb. per acre in October 1998. A total of 8 acres was treated with hopes of limiting their spread.

The third and largest demonstration was located in Beebe. The area of the infestation was the City Park and the newest subdivision in west Beebe. The Extension Service worked closely with the Mayor and City Council to educate on the economic impact and importance of treating fire ants. Fire Ant educational programs were held for the City Council, city road department, civic clubs and general public. A neighborhood abatement program was developed and implemented by the city under the direction of the Extension Service. A broadcast bait application of Amdro® was applied at 1 lb. per acre on 688 acres in June of 1999.

One key to the success of the Beebe Neighborhood Abatement Program has been the involvement of the community and city government. A concerned Mayor and City Council who wanted to prevent problems from occurring rather than ignoring them until things were out of hand was also another very important key. Another vital aspect of this overall county program has been the seven educational meetings held for the media, public and government officials.

Results

County Fairgrounds:

Following the first report of fire ants in August 1998, 49 fire ant mounds was found on the grounds. The infested area of the 80 acre fairgrounds was approximately 5 acres where the buildings and improvements were located. After the initial evaluation of mounds, 34 bait stations were placed in various locations. Twenty-one of the thirty-four stations were positive for imported fire ants. Twelve of the bait stations had native ants. The information assimilated from the bait stations was presented to the fair board. There was a sense of urgency with the fair closely approaching and the fear of liability if someone was stung by fire ants during the fair. Another concern was that if the news spread about the infestation it would cause mass panic and a loss of revenues for the fair. The fair board approved funding for treating the entire grounds (80 acres). The Extension Service worked with local media to postpone the story until a mass public educational program was conducted by the Extension Service.

The fairgrounds were treated in August 1998 with a broadcast bait application of Amdro® at 1 lb. per acre. Areas around buildings were treated using hand spreaders and a tractor mounted Herd® spreader was used to treat the remaining acreage. Two weeks after the bait treatment an insecticide treatment was made to active mounds and around buildings. Talstar® was applied at the 1 fluid oz. per gallon of water rate. Active mounds were drenched with one gallon of the Talstar® mixture. There were no reports of fire ants or injury from fire ants during or after the fair.

In August of 1999 bait stations were placed in same location as in 1998. There were nine of the thirty-four bait stations that were positive for fire ants, a 43% reduction in positive fire ant bait stations. Eleven of the bait stations had native ants. Infested areas of the fairgrounds were treated with a broadcast bait application of Amdro® and Logic® (1.0% fenoxycarb) following the same procedure as the previous year. Individual mound treatments with Varsity™ (0.011% abamectin) bait was made on the same day as the broadcast application. No contact insecticide was applied after the bait application. Again, there were no reports of fire ants or injury from fire ants at the fair.

Beebe:

As mentioned earlier, fire ants were first reported in the county at Beebe in the spring of 1996. There was no organized treatment taken until the fall of 1998. Any treatments made were on an individual basis. The first plan of action in Beebe started with a meeting of the Extension Service and Arkansas State Plant Board. The concern of the Plant Board was somewhat personal. Several employees of the Plant Board reside in Beebe and were concerned that if White County was included in the Federal Fire Ant Quarantine that the "door would be open for mass infestation of the county." The initial meeting evaluated the reported fire ant infestations in the county. It was immediately noted that Beebe topped the county in size of fire ant infestation.

As a result of the meeting with the Plant Board it was decided to contact the newly elected Mayor of Beebe to report the infestation and related concerns. The meeting was an eye opener for the Mayor, who was not aware of the situation. It was explained that often fire ants are moved through landscaping material. This was a major concern for the Mayor. On January 21, 1999, an F3 tornado hit the town of Beebe, destroying more than ninety homes. The town was in the middle of reconstruction plus continually increasing growth because of people moving from the metropolitan area of Little Rock. This reconstruction and growth was an ideal situation for the spreading of the fire ant infestation. The Mayor felt very strongly that the city should be responsible for treatment of the infested areas. The extent of the infestation of Beebe was not known and a plan to map out the infested areas was initiated.

The Extension Service and the State Plant Board using global positioning satellite units (GPS) mapped the infested areas. The main concentration of the infestation was in west Beebe, in a subdivision and city park. This part of the city is the newest and most rapidly growing part of town. A majority of the infestations were related to landscaping materials being brought in from Federal Fire Ant Quarantined counties or states. The infestation came to a total of 688 acres and more than 200 households. A portion of the infestation was located outside the city limits. The acreage included 228 acres outside and 460 acres within the city limits.

The infestation map was brought to the Mayor and a plan for a neighborhood abatement program was initiated. The first stage of the plan was to conduct an educational program for the City Council on the situation and urgency of the fire ant infestation. The City Council appropriated $4,000 to the neighborhood abatement program. This appropriation was made from money set aside for the mosquito abatement program.

A fire ant educational program was also held for the Quorum Court. This sparked another meeting of the County Judge, Beebe Mayor and Quorum Court members from the Beebe district. This meeting resulted in another $4,000 appropriation for the areas located outside the Beebe city limits.

The next stage of the abatement program started with public education. The program kicked off with a media day, which included fire ant presentations and distribution of press packets to the county media. Following the media day, several public meetings were held and several civic club presentations were given. A major focus was given on the Beebe public meeting. The local 4-H club was recruited to hand out flyers on the public meeting to the infested neighborhoods. The 4-H club was also used to distribute flyers about treatment dates and procedures.

The publicity was instrumental to the success of the program. The Mayor said "He had residents flagging him down to make sure their property would be treated." There was a 60% increase of calls to the Extension Service and a 100% increase to City Hall regarding suspected infestations and the abatement program.

A training session was conducted for the city road and water department to insure proper bait application and to educate staff on proper identification of fire ants. The neighborhood abatement program started treatment on June 30, 1999 with a 1 lb. per acre broadcast application of Amdro®. The bait was applied with two herd spreaders mounted on an all-terrain vehicle (ATV) and a tractor. Some applications were made with hand spreaders.

There was no follow-up treatment in the fall made because of lack of funding. However, a demonstration was conducted on the city park ground in the fall. Distance (0.5% pyriproxyfen) fire ant bait was broadcast at a rate of 1 lb. per acre. Individual mounds were also treated with Varsity® fire ant bait.

There was an overwhelming acceptance of the program. All but one resident allowed the treatment. This one resident refused to have their pasture treated, which was located in the county outside the city limits. There was a 50% reduction of fire ant mounds and complaints. Many residents were quoted saying "the number of mounds was greatly reduced to the point they could work in their yards without much worry"and "last summer I had 20 mounds and this summer only two or three."

The Beebe Neighborhood Abatement Program was successful because of the cooperation of the different government agencies (Cooperative Extension Service, City of Beebe, White County Quorum Court and Arkansas State Plant Board). This cooperation allowed the community to become a part of the solution to slow the progression of fire ants in White County. Community involvement was very vital to the success of the program.

Discussion

Plans have been made to re-appropriate moneys for the Beebe Abatement Program in 2000. The Extension Service has planned to conduct programs in the Beebe Schools to help educate and promote the abatement program. Educational programming for the public will continue throughout the county. A concentrated effort will be made by the Extension Service to educate the citizens of Searcy about fire ants. Searcy has a great potential for major infestations due to its growth and reports of fire ant infestation in Searcy continue to grow. The Mayor of Searcy has, off the record, agreed to cooperate in any way possible if the problem becomes serious like Beebe. The remaining areas of the county will be monitored and educated about fire ants.

Experiences from other Arkansas abatement programs have show that persistence, commitment, education and community support are essential for a sustained and successful abatement program. Educating and gaining community support through public meetings, area displays, and demonstrations is the most effective approach. Another important factor to remember is that one person can make or break an organized abatement program.

The key to this or any abatement program is education and community support. As mentioned earlier if the community has ownership of the program the more successful it will be. In the case of Beebe, all major components for a successful abatement program were in place. The Extension Service provided the educational support and the Beebe Mayor provided the leadership necessary to gain the community support.

Government officials as well as citizens of White County are well aware of the fact that fire ants cannot be eradicated. But, they understand that by taking this pro-active approach problems associated with fire ant can be lessened and the rate of infestation may be decreased. We hope that through continued fire ant education community support for the program will continue.

MOTIVATION OF HIGH SCHOOL YOUTH'S INTEREST IN FIRE ANT RESEARCH

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Abstract

Interest in studying the Red Imported Fire Ant by youth is high during elementary school years, but is not as evident during high school years. Whether this is a result of curriculum changes or entomology in general not being viewed as interesting as other biology areas is unknown. In either case, there tends to be very few students who display a deep interest in continued fire ant studies or research. The Miller County Cooperative Extension Service has shown success in involving High School Students in continuing their growth in fire ant studies through involvement in science fairs, research papers, and demonstrations.

Discussion

Each year over 1,500 elementary students in Miller County are introduced to fire ant studies through programs, activities, educational materials, Extension Service web pages, and demonstrations. By the time a student reaches the seventh grade, he/she has participated in at least one of these learning activities. Although the activities (such as the use of coloring books, puppets or videos) used with first through third graders may be considered fairly simplistic the student will associate fire ant information and research with the Cooperative Extension Service. Thus as the student progresses in his/her studies, they are more likely to contact the Extension Service for the latest in research.

Some examples of continued youth interests in fire ant studies are through: Term Papers involving fire ant related topic, Research conducted as a class project, and Science Fair projects.

Student submitted term papers have ranged form: Great Mounds of Fire, a 12 page summary of the biology, history, and research of fire ants in the United States, to A Royal Wedding, a 12 page report on the mating habits and early colony development among single queen colonies. When working with these youth, it is important that you only assist with the gathering of information and provide guidance in keeping the subject relevant but not write the paper for them.

Some classes have been involved in conducting their own research on fire ants. One such research project involved testing the effectiveness of a fire ant bait applied around the exterior walls of the school on controlling the number of fire ants found in the interior of the building. Another class research project compared the effectiveness of different chemical fire ant control measures. In these class projects, not only was the student exposed to informative subject matter, but was also exposed to the scientific procedures involved in research. They designed the test, studied the subject matter, implemented the test, measured and evaluated the results, and surmised the reason for the results.

Science Fair Projects are very effective at involving youth in fire ant studies. Through these projects, students look at other research and develop their own tests and theories. Some of the most involved projects that I have been involved in were: (1) Pheromone Trailing of Fire Ants; a project where the trailing pheromone from 100 workers was extracted and placed on a line of a piece of graph paper. A foraging trail was then established through a tube from a colony to the center of the graph paper where the pheromone trail began, then food was placed at opposite ends of the graph paper. The student recorded the amount of time it took ants to find the food following the trail he had laid compared to the food without a trail. He also recorded how far the ants wondered off course going to the food at each end of the graph paper. This was repeated four times. One science fair project was: (2) Radiosensitivity of Fire Ants; a project in which 8 containers of 25 fire ants were exposed to different levels of radiation from 0 Rad to 4500 Rad and then observed for six days following the test. Survival for all rates was 94% or higher (except for one sample that was accidentally downed, the second day). Another science fair project was: (3) Olfactory Ant Antics; a project testing the fire ant's response to oleic acid. One hundred ml of air dried fire ants were crushed and the oleic acid was extracted using an acetone wash. The acetone was evaporated and the oleic acid was mixed with water and a phosphorescent dye, then sprayed on live ants and a toothpick. The treated specimens were then placed in an established mound. The treated ants and the toothpick were treated as dead ants and carried to the dead ant piles as if they were dead. In one case a dead pile was not established, so a corner of the container was treated with the oleic acid solution and the ants established the dead pile at that location.

Although these types of projects are not always as involved as the ones mentioned, they do require a certain amount of research of information and an interest in continued fire ant studies.

PROGRESS REPORT: THE TEXAS IMPORTED FIRE ANT RESEARCH & MANAGEMENT PLAN

September 1997 - March 2000

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ABSTRACT. In 1997, the Texas legislature funded the Texas Imported Fire Ant Research & Management Plan, providing $2.5 million annually to support research, education and regulatory programs to address the problems fire ants are causing in the state. The six-year plan is being implemented by the Texas Agricultural Experiment Station, the Texas Agricultural Extension Service, the University of Texas, Texas Tech University and the Texas Department of Agriculture. The goal of the plan is to eliminate the fire ant as a pest of major health and economic significance. The red imported fire ant, ***Solenopsis invicta*** **Buren** (Hymenoptera: Formicidae) has been estimated to cause $300 million in losses to Texas annually, with $67 million in losses to the cattle industry alone. Efforts are being focused on developing sustainable solutions such as biological control and genetic methods as well as improve integrated pest management solutions that are cost-effective and environmentally sound. Educational programs are promoting managing the fire ants on a community-wide basis using currently available technology and the "Two-Step Method" wherever applicable. Information about the Plan can be found on the web site, http://fireant.tamu.edu.

INTRODUCTION

The red imported fire ant, ***Solenopsis invicta*** **Buren,** infests the eastern two-thirds of Texas, with localized infestations in Midland and Ector Couties, Lubbock and El Paso. Losses have been estimated at $300 million. Aside from medical impact to man and animals, the ants disable electrical and farming equipment. The multiple queen form of the ant is increasing the damage they do. This accidentally-introduced species has become the dominant ant species, in part, because they were introduced without the compliment of natural enemies that occur in South America. There are more than 3 million households in Dallas/Fort Worth, Austin, Houston, and San Antonio, and losses there were previously estimated at $93 million per year. Overuse and misuse of ant mound treatments is blamed for contamination of surface runoff water in several Texas cities, including Fort Worth.

PROJECT ACTIVITIES

In 1997, Texas institutions implemented the Fire Ant Research and Management Plan. The goal of the plan is to eliminate the red imported fire ant as a pest of major economic and health significance. About 35 projects were funded under the Plan at the University of Texas, Texas Tech University, Texas Department of Agriculture and within the Texas

A&M University System (Texas Agricultural Experiment Station and Texas Agricultural Extension Service). Extension IPM agents have been placed in Dallas/Fort Worth, Austin, Houston, and San Antonio to educate the public and promote community-wide management fire ant programs. Extension publications and over 25 fact sheets have been developed, and together with additional information, including research summaries, are posted on the web site, http://fireant.tamu.edu. The Texas state legislature proclaimed Fire Ant Awareness Week to be the 2nd week in September. To highlight research progress and to promote community-wide fire ant management, information packets to County Extension Agents and media, videotape and radio programs were promoted in all major media markets. In Dallas and Tarrant counties shopping mall posters and city bus signs were developed and posted in 1999 instructing viewers interested in fire ant management information to call a toll-free number (877/288-ANTS).

PROGRESS AND IMPACT

Final reports are being posted on the web site and are available for all funded projects documenting progress made in developing sustainable and better pest management methods for suppressing fire ant populations. Dry summer conditions have dramatically suppressed fire ant populations. Below are highlights of progress made by some of the funded research projects:

Biological Control Research. The parasitic phorid fly, *Pseudacteon tricuspis*, has been mass produced and released in 5 experimental locations by University of Texas researchers (Gilbert), and other species have been evaluated for possible release. Initial establishment of several *P. tricuspis* populations was documented in mid-1999 prior to severe drought in late summer and fall; the flies were recovered near Laredo in March 2000 from releases made in 1999. At Texas Tech University (Thorvilson & San Francisco), a strain of the fungus, *Beauveria basianna* formulated as a non-spore containing bait, continues to be field-evaluated, and in the laboratory cultures it has been genetically modified with a marker gene that will allow researchers to following this organism when released into the field. At Texas A&M University, the disease, *Thelohania* spp. is being investigated to determine species/strains present, mode of transmission and impact on fire ant populations (Vinson & T. Cook). Several institutions are investigating native and exotic ant species have been identified as capable of competing with fire ants, preying on fire ant queen ants or eliminating small fire ant colonies.

Physiology and Genetics Research. Hormonal and communication systems (pheromones, sound) have been under investigation to determine the likelihood of developing behavior-modifying approaches, and the genetic make-up of the fire ant has been studied with the development of a genomic DNA library (Skow & Vinson). A gene encoding a portion of a putative G protein-coupled receptor has been isolated and sequenced. In addition, genes with sequences corresponding to a proton channel from a vacuolar ATPase and a putative glucose transporter have been isolated (Pietrantonio).

At the University of Texas, pheromone control of reproduction in fire ant colonies (Vargo) is being studied to delineate the roles that queen pheromones play in the integration of the social colony of the red imported fire ant. The queen pheromone is a potent inhibitor of reproduction in new virgin queens, it suppresses reproduction among co-inhabiting queens, it inhibits the production of new queens and males, stimulates the execution of young queens, and acts as a releaser pheromone, attracting workers to attend the queen. Careful excision experiments followed by behavioral assays have shown that the head may be a source of queen pheromones. These glands will serve as a source for new bioassay-directed chemistry. In addition, endocrine regulation of reproduction experiments were proposed to determine how the primer pheromones from queens result in suppression of young virgin queen reproduction. The releaser pheromone was found to be produced 2 days after dealation, whereas the primer pheromone was found 3 days after wing-shedding. A 3rd, "assassination" pheromone, was also quantified with behavioral assays. This time-course should be useful for the extraction of specific semiochemicals. In the developmental pattern of JH in fire ants, the titer of JH was found to rise after the mating flight, suggesting a role in "queenness" and vitellogenin production.

Endocrine regulations of queen reproduction are also being investigated at Texas A&M University (Keeley & Vinson) to: 1) isolate and characterize a blood-borne factor (FMHF) that causes flight-muscle histolysis after the mated queen lands; 2) characterize changes in vitellogenins (Vg) in different castes and different ages; and, 3) study the regulation of reproduction (dealation and egg production). A Vg gene has been isolated from fat body, a putative Vg receptor has been isolated from oocytes, and a fat body in vitro system will facilitate studies of Vg synthesis using radio-tracers.

A Texas Tech University researcher (Deslippe) is investigating the elimination of queens by worker ants. The aim of this research is to understand the regulation of worker execution of queens. Chemicals in worker ants of different ages have been characterized, quantified and compared. Comparisons of venom alkaloids and chromatographic analysis have shown that alkaloid content (relative amounts of saturated and unsaturated alkaloids) is related to worker size and age, suggesting that venom composition changes with behavioral roles of workers. In the long-range, this information may be useful to biochemical and gene expression studies of alkaloid production.

The design of protease inhibitors to disrupt the ability of fourth instar ants to digest large food particles is being investigated at Texas A&M University (Meyer). One of these enzymes (chymotrypsin) has been purified, crystallized and partially characterized. Work is ongoing to synthesize and test unique inhibitors for this enzyme. At the University of Texas at San Antonio (Renthal, Wayner & Armstrong) the response of fire ant antennae to odorant and pheromone stimulations is the focus of research. From a morphological study of the fire ant antennae, a new antennal gland has been discovered and its topology described.

Economic Assessment. The ant's economic impact in major Texas urban areas is now known to be $581 million, substantially greater than the previous estimate. These new figures document losses in Austin ($61 million), Dallas ($121 million), Fort Worth ($75 million), San Antonio ($202 million) and Houston ($122 million); with $526 million for households, $29 million for golf courses, $25 million for schools and $0.6 million for cities; partitioned into costs for treatment ($302 million), repair ($81 million), replacement ($152 million) and medical costs ($47 million) (Salin, Lard & Hall 2000).

Survey and Regulatory. With support from the Texas Department of Agriculture (Sneed, Kostroun & Bhatkar), western Texas counties have been surveyed (Gilbert, Philips, Thorvilson & MacKay) and none have been quarantined. In addition, an internet delivered GIS-based system, FASIMS (Fire Ant Spatial Information Management System) has been developed that documents ant distribution together geographical data (Coulson & Vinson).

Extension Education and Applied Research by the Texas Agricultural Extension Service: In 1999, County Extension Agents - IPM (Fire Ant Project) in Dallas/Forth Worth, Houston, Austin and San Antonio and statewide support staff made about 30,000 contacts and made presentation to over 80 community groups (Lennon, Riggs, Russell, Traylor, Barr). Communities have been selected as "showcase pilot" projects to measure the effectiveness of community-wide management programs. Results have documented success in dramatically eliminating fire ants and the problems they cause, as well as reducing the cost of fire ant control efforts to homeowners. A number of other neighborhood groups have received information about fire ant management alternatives and proper use of insecticides, along with training and support to develop their own community-wide fire ant management programs.

Applied research to document performance of fire ant control products has helped introduce three new fire ant bait products to the market: Distance® (pyriproxyfen), Extinguish® (methoprene), and Eliminator® Fire Ant Killer Bait (spinosad). Extinguish is registered for use in cropland and livestock pastures. In addition, the individual fire ant mound treatment product, Citrex™, containing d-limonene, was also introduced after evaluations conducted by the Texas Agricultural Extension Service. A section on the web site, http://fireant.tamu.edu, was developed for quick easy access to fire ant research, education and regulatory information; result demonstration/applied research reports issued since the late 1980's have been posted on the web in a searchable format (Barr & Best).

A new publication, "Managing Red Imported Fire Ants in Agriculture"(B-6076), was developed together with Extension Services in Arkansas, Louisiana, Georgia, Alabama and Tennessee, and the revision of "Managing Imported Fire Ants in Urban Areas" (B-6043) has been coauthored by Extension, regulatory and research personnel from Texas, Georgia, Louisiana, Arkansas, Tennessee, Alabama, Florida, South Carolina and Oklahoma. "The Texas Two-step method: Do-it-yourself Fire Ant Control for Homes and Neighborhoods" (L-5070) has been revised and reprinted twice (60,000 copies), and other publications on other ants ("Red Harvester Ants" - L-5314; and "House-infesting Ants and Their Management" - L-2061) have been developed and released. In addition, nearly 25 Fire Ant Plan Fact Sheets and issued three volumes of the newsletter, *Fire Ant Trails*, have been issued on a wide variety of topics and newsworthy developments for managing fire ants. These are all posted on the web site and/or available upon request.

Outside funding has been obtained from: 1) the Texas Department of Transportation to develop a fire ant management manual for road service crews, a pamphlet for visitors to Texas and prototype bait applicators were produced to treat roadside areas using backpack worn or truck-mounted bait blower; 2) the Texas Army National Guard supported research to evaluate bait products applied to firing ranges, fire ant control around electrical installations and selective elimination of imported fire ants in areas inhabited by harvester ants; and, 3) private industries that continue to fund numerous result demonstrations/applied research trials to assess the performance of recently registered and experimental fire ant control products and methods.

A partnership through the Southern Legislative Conference (SLC) with the United States Department of Agriculture (USDA) Agricultural Research Service (ARS) was established to support the National Imported Fire Ant Strategy in 1999. This partnership allowed Texas researchers (Gilbert et al.) to receive quantities of *P tricuspis* to supplement Texas mass rearing efforts. Phorid flies (*P. tricuspis*) were released near Elgin and Dobbin through Extension Service and Texas Army National Guard efforts (J. Cook).

Marketing and Promotion. House Concurrent Resolution 259 was passed and signed by Gov. George W. Bush declaring the second week of September as Fire Ant Awareness Week. As a result of the Fire Ant Awareness Week campaign, page accesses to the web site averages 100,000 "hits" a month. Furthermore, every major Texas newspaper in fire ant quarantined areas published one or more articles based on news releases provided, and overall more than 500 articles were published in connection with the 1998 and 1999 campaign (James & Lockaby). In addition, the Extension offices in Dallas and Tarrant counties received about 50 calls per day during Fire Ant Awareness Week with 93 calls received at the toll-free metro number (Porter, Merchant & Russell).

Peer Review. In October of 1998 and November of 1999, a Peer Review Committee composed of scientists from outside of Texas conducted extensive reviews of each project funded by the Texas Fire Ant Research & Management Project. The participation of Peer Review Committee members Cliff Lofgren (Chair 1998), David Williams (Chair 1999), Sanford Porter (1998), Jim Ottea, Coby Scal, Beverly Sparks, Chip Taylor (1998), Anita Collins (1999) and Robert Taylor has been greatly appreciated. Some of the research highlight text sections above were edited from their 1999 report. Executive summaries of these reviews have been released as articles in *Fire Ant Trail* newsletters and can be viewed on the web site, http://fireant.tamu.edu.

FIRE ANT MANAGEMENT PROGRAM IN A PUBLIC HOUSING PROJECT - MOUNT PLEASANT, TEXAS

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Introduction

The Showcase Program at the Mount Pleasant Housing Authority was initiated to demonstrate the efficacy, economy and practicality of community-wide fire ant management in a high-density housing situation. Several of the foundations of Integrated Pest Management (IPM), upon which these management programs are based, are to reduce pesticide usage, increase effectiveness and reduce cost. The Housing Authority proved to be an almost ideal location to illustrate these principles.

Furthermore, the Housing Authority population was made up almost entirely of elderly/disabled persons and families with young children, two groups particularly at risk of fire ant injuries. Control of fire ants in areas frequented by these individuals becomes a matter of safety rather than convenience. The project also gave us the opportunity to hold a meeting to publicize the Red Imported Fire Ant Research and Management Plan and educate the public on fire ants and their management.

The Mount Pleasant Housing Authority

The Mount Pleasant Housing Authority is funded through the U.S. Department of Housing and Urban Development (HUD). It consists of about 22 acres near a major highway intersection just south of the city of Mount Pleasant business district in northeast Texas. Mount Pleasant is about two-thirds of the way between Dallas and Texarkana on 1-30 and is the county seat of Titus County. The Authority is managed by Ms. Candace Martin who first brought their fire ant problem to the attention of her long-time friend, Mr. Dick McCarver who is the Titus County Agent. The complex includes 120 single-story units in duplexes, triplexes and four-plexes. The units are arranged along winding streets and several cul-de-sacs. Families, comprising about 20% of the population, occupy one end of the complex with elderly and/or disabled residents occupying the rest.

It must be stated that the Mount Pleasant Housing Authority does not fit the popular perception of a "housing project" - a barren, littered, broken-down set of drab buildings infested with drugs and crime. Rather, the area is shady, very well kept and rather pleasing in appearance. Over the years, residents have added landscaping around their units and many of the more active elderly residents take considerable pride in their yards.

Associated Educational Activities

By coincidence, a regional meeting of housing authority managers was held at the Mount Pleasant site on 16 September. Rody Best briefed them on the Fire Ant Plan and upcoming activities. Several managers have been in communication with Ms. Martin since that time. The management plan for the Authority was formally initiated on 17 September 1998 during the first Texas Fire Ant Awareness Week with a press conference held at the Housing Authority.

Approximately 60 people attended and speakers included: Hon. Tom Ramsay (D - Mt. Vernon), the sponsor of the Fire Ant Plan; Mr. Randy Upshaw - TAEX District 4 Director; Dr. Bart Drees, Fire Ant Plan Coordinator; Mr. Dick McCarver and Dr. Charles Barr. Several local dignitaries were also present. A display and handouts on fire ant management were also available. Following the presentations, demonstrations on proper methods of broadcasting fire ant bait were conducted. Several members of the print and television media were in attendance and stories on the project were broadcast by stations in Tyler, Texarkana and Shreveport, LA.

Materials and Methods

Biological Survey Activities

Before treatments were initiated, surveys of both fire ants and native ants were conducted. Fire ant populations were assessed by counting the number of active mounds in randomly selected plots on 16 September. Because of so much paved area, it was impossible to create plots of uniform size. Rather, plots were designated following sidewalks, streets, walls and other convenient landmarks as borders. The features were noted, measured where possible and a sketch made of the general shape of each plot. Plot locations were referenced to unit number and geo-referenced by GPS using a Trimble XRS Pro receiver. At a later date, Rody Best used a computer landscape program to convert the measurements and sketches into scale drawings of each plot. The area of each was also calculated. In this way, mound counts could be standardized to a mound density basis. Mound activity was evaluated using the minimal disturbance technique. Post-treatment mound counts were taken on these same plots on 15 October and 15 December 1998, 16 March and 22 September 1999.

The total ant population was sampled using glass vials baited with soft, dry cat food which were placed in the previously designated plots. Vials were set out the morning of 17 September and allowed to sit for approximately one hour. They were then picked up, sealed, filled with alcohol and stored for later identification and enumeration .

Resident Surveys

Prior to arrival in Mount Pleasant, we were warned by Ms. Martin that most of the residents had very low reading levels. To compensate, a simple, one-page survey was developed to help assess the different types and severity of fire ant problems the residents encountered. We were also cautioned that many residents were wary of people coming to their doors and that some of the more severely disabled residents found it nearly impossible to answer a knock. Consequently, we decided to approach residents who happened to be outside.

It quickly became apparent that reading levels were *very* low and that the only way to obtain useful information was through informal interviews. Consequently, survey forms were used only as a guide when interviewing residents who were outside. Efforts were made to sample residents from all parts of the complex and to include young residents with families as well as the elderly. A similar method and identical survey was used to assess resident opinions on 22 September 1999.

Treatment

Fire ant mound counts indicated that the entire complex was moderately to heavily infested. Therefore, a broadcast bait applied to the entire area was deemed the most appropriate treatment strategy. For faster suppression, Amdro® (0.7% hydramethylnon) donated by American Cyanamid Corp. was the bait of choice. Treatments were applied during the afternoon of 17 September using a Herd GT-77 electric seeder with a fixed blocking plate over the gate. The seeder was mounted on a John Deere 4x6 'Gator utility vehicle. Because of its very light "footprint," the 'Gator could be driven anywhere in the complex without leaving unsightly tracks or ruts. One person drove the vehicle and operated the seeder switch while another kept track of areas that had been treated on a scale map. Temperature at the time of treatment was approximately 85°F, skies were partly cloudy with a light breeze. The area had been under severe drought conditions from May until the previous week when a tropical storm brought approximately 10 inches of rain. Consequently, the soil was very moist, but no rain occurred for several days following treatment.

Treatments were repeated 22 September 1999 using similar equipment. The broadcast bait, however, was changed to Extinguish™ (0.5% s-methoprene), a slow-acting insect growth regulator that would hopefully provide longer ant suppression than the Amdro.

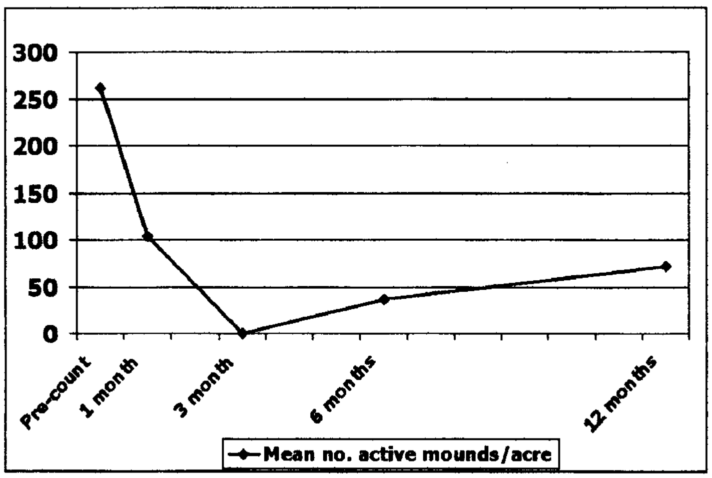
Results

Biological Survey

Figure 1 shows a graph of the mean number of active fire ant mound populations in the 15 designated plots, adjusted to a per-acre basis. Most of the mounds found at the one month evaluation were in only three plots. It was surmised that ant colonies in these plots, all in full sun and dry sites, had not fully "geared up" after the drought and were not foraging on oily materials, such as bait. Amdro was re-applied to these three plots on the 3-month evaluation date.

Even at one year post-treatment, mound numbers were only 27% of pre-count levels. The reduction was easily visible when compared to the year before. Examination of bait vials indicated that *Solenopsis invicta* was present and exclusive in all but one. That vial appeared to contain three pyramid ants, *Dorymyrmex pyramicus,* whose distinctive cone-shaped mounds were noted in the area of that plot. One of the residents of this area reported that he regularly treated mounds, a possible reason for the existence of something other than a red imported fire ant.

Figure 1. Mean number of active fire ant mounds.

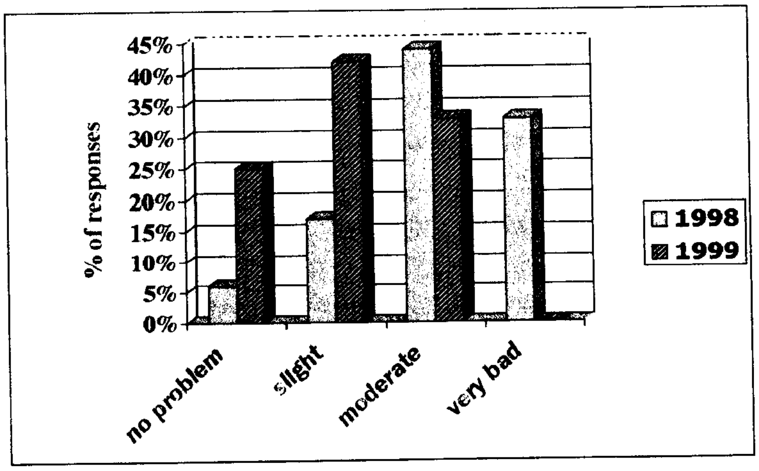


Resident Surveys

Even though relatively few residents were interviewed, 18 and 12, in 1998 and 1999 respectively, they represented about 15% of the residences. The number of occupied units was down considerably in 1999 due to major remodeling. One advantage of the informal interview format was that the interviewer got a "feel" for resident opinions, not just simple answers. These observations were reflected in the actual data. Several questions on the survey drew lukewarm, confused or no responses, so we stopped asking them. A more complete accounting of responses will be presented as this program continues. Below are some comparisons from 1998 to 1999.

The first question usually asked of residents was, "How big a problem are fire ants in this neighborhood?" Results comparing 1998, before the start of treatments, and 1999, a year after program initiation are presented in **Figure 2**. The most striking observation is that none of the residents surveyed in 1999 felt that fire ants were a "very bad" problem. In 1998, a third of the respondents felt that they were a very bad problem.

Figure 2. Responses to "How big a problem are fire ants in this neighborhood?"

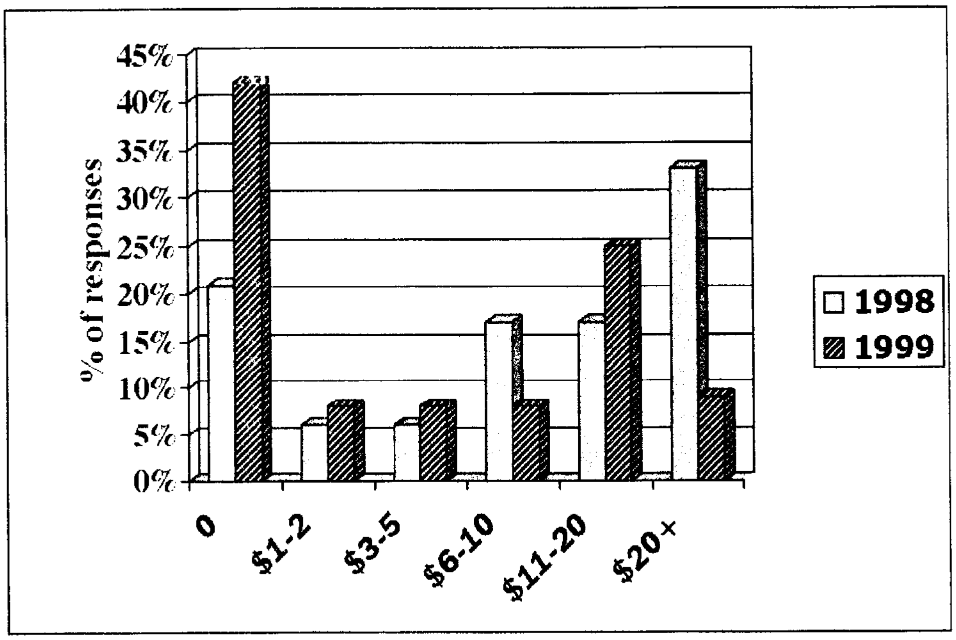


On a scale of 0-3 with "0" being no problem and "3" being a very bad problem, the mean answer in 1998 was 2.1, or "moderate". In 1999 that mean had dropped a full point to 1.1, or only a slight problem.

Another question of interest was how much money people spent controlling fire ants in a normal year. It must be remembered that all these people were on an extremely limited budget (or they couldn't have lived in subsidized housing). One elderly lady interviewed in 1999 mentioned that her income was $399 per month, yet she spent some of that on fire ant control. **Figure 3** shows the distribution of the responses to the question, "How much do you spend per year controlling fire ants now?"

Note the downward shift in expenditures from 1998 to 1999. The mean (using range midpoints) dropped from $12.50 in 1998 to $7.08 in 1999. Informally, we tried to find out what the residents used to treat for fire ants. Most said they didn't know, but showed us the container sitting on their porch. We can only imaging how well label directions were followed! Granular diazinon, chlorpyrifos and acephate dust (Orthene®) were the most common products. None reported using a bait for either individual mound treatments or broadcast treatments.

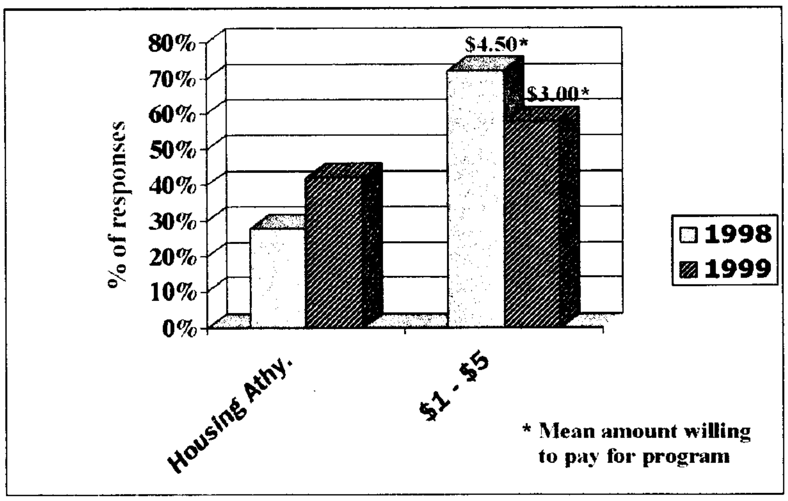
Figure 3. Response to "How much do you spend per year controlling fire ants now?"



Finally, we asked residents whether they would be willing to pay, and how much, to be part of a program that treated the entire complex if everyone else had to pay, as well. Results are presented in **Figure 4**. Not surprisingly, many felt it was the Housing Authority that should pay and that number increased from 1998 to 1999. The amount people were willing to pay also dropped considerably.

There is good news and bad news in these responses. The bad news is that a substantial number of people were not willing to, or could not afford to, pay for such a management plan. The good news is that a majority were and that the amount they were willing to pay would cover the costs of treatment products. These results also point out a curious trend in human nature. More people are willing to pay more when a problem is bad. When the problem subsides, they shift the burden and/or their resources elsewhere.

Figure 4. Responses of people willing to participate in complex-wide program and for how much.



Treatment Economics

As mentioned, the two or three dollars many residents would be willing to pay for a fire ant treatment program would be enough to cover the product costs. The housing complex encompassed a total of 22 acres. It is estimated that approximately two-thirds of that area is either paved or buildings, giving a total treatable area of only (rounding up) eight acres. If purchased in 25 lb. bags, most baits cost around $8.00 per pound. Therefore, an expenditure of about $70 per year ($140 if two treatments were required) for just the product could cut fire ant populations by 80-90%. It is suspected that repeated treatments would all but eliminate fire ants, requiring, at most, one treatment per year and maybe less. There would, of course, be costs associated with applying the bait, but even a doubling of two treatments per year would result in a cost of only about $2.00 per unit.

Conclusions

The fire ant management program at the Mount Pleasant Housing Authority can be considered a success on almost every level. There was considerable local and regional publicity obtained from the press conference. Fire ant populations were cut to zero within three months and stayed at less than 30% of the pre-program levels for a year. Residents reported a greatly reduced, though not eliminated, fire ant problem. Expenditures on and use of fire ant control products was reduced, not only saving the residents money, but reducing the potential of runoff and leaching from overuse and misuse of contact insecticides.

Even though the likelihood of resident financial participation in such a plan seems unlikely, this story has a happy, long-term ending. During our last visit, Ms. Martin reported that, due to a change in HUD funding strategies, small complexes such as Mount Pleasant, would be automatically receiving block grants rather than being forced to compete for funds with larger projects. Though the idea of having a utility vehicle like our 'Gator seemed to appeal to her as much as fire ant control, she indicated that they would be spending some of that grant money on a bait spreader and fire ant bait on a regular basis. We will continue to monitor the progress of the showcase program at the Mount Pleasant Housing Authority.

A TALE OF TWO NEIGHBORHOODS: EXAMINATION OF FIRE ANT INFESTATIONS BEFORE AND AFTER COMMUNITY-WLDE FIRE ANT TREATMENTS IN TWO SAN ANTONIO, TEXAS NEIGHBORHOODS

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Abstract

The Jade Oaks and Countryside Neighborhoods in San Antonio, Texas instituted community-wide treatment programs for fire ant management in the Fall of 1998 and Spring of 1999. Fire ant-related treatment costs prior to initiating these programs averaged $111.30 for 55% of survey respondents and $38.33 for 82.8% of survey respondents, respectively. Pre-treatment mound counts averaged 4.7 per lawn and 0.1 per lawn in the two neighborhoods and were reduced to zero from 2 weeks to 6 months after treatment. Prior to treatment, biological surveys captured 5 species of ants (including fire ants) in Jade Oaks and 11 species of ants (including fire ants) in Countryside. Post-treatment surveys captured 3 ant species and 13 ant species respectively. Lawns in Jade Oaks were treated with a broadcast application of AMDRO® Fire Ant Bait (hydramethylnon) while Countryside lawns received a broadcast application of PT® 370 ASCEND™ Fire Ant Stopper^W Bait (abamectin).

Introduction

Red Imported Fire Ants (Solenopsis invicta Buren) have been responsible for anywhere from $300 (Texas Imported Fire Ant Research and Management Plan) to $581 million (Lard, et al) in losses to Texans each year. These damages come in the form of chemical and medical treatments, destruction of electrical equipment, and livestock losses. The largest source of pesticide expenditures against fire ant infestations occurs in urban areas. Costs attributed to fire ants in the San Antonio area alone were reported at $16.7 million in 1992 (Texas Imported Fire Ant Research and Management Plan) and $202 million in 1998 (Lard, et al). The Jade Oaks and Countryside Neighborhoods represent two distinctly different neighborhoods in terms of their ecosystems and fire ant infestation level. Each neighborhood instituted a community-wide fire ant management program with assistance from the Texas Imported Fire Ant Research and Management Plan.

The Neighborhoods

The Jade Oaks neighborhood is relatively new with home construction beginning during late 1996. The neighborhood is located in northwest San Antonio and is surrounded on three sides by post oak savanna and native grasses. The average lot size in Jade Oaks is –7,600 R^2 including the home. Actual turf on each lot averages –4,000 R^2. The majority of lots contain a range of shade from 0 to 35%. Turfgrass is primarily St. Augustine variety with a small number of Zoysia and Bermuda variety lawns as well.

The Countryside neighborhood is older with homes ranging in age from 15 to 25 years. The neighborhood is located in north central San Antonio and is surrounded by homes on three sides and a large creek/wash area on the other. Average lot size is ~7,950 ft^2 including the home. Average turf on each lot averages ~5,500 ft^2. The majority of shade is provided by mature trees in a range of 35 to 80%. All lawns contain an assorted mixture of St. Augustine and Bermuda grasses.

Materials and Methods

Jade Oaks Neighborhood

Fifteen of the 91 homes in the neighborhood were randomly selected as sites for biological surveys and mound counts. Four small condiment cups were baited with small pieces of canned tuna, placed in a transect across the front lawn of each site and allowed to remain for at least 30 minutes before being collected and capped. Mound counts were taken for the entire lot. Shade cover and turf type were recorded for reference. In September of 1998, homeowners selected Amdro® Fire Ant Bait (hydramethylnon) as their management tool in conjunction with the Two-Step Method of fire ant control. A choice of 6 oz. or 1 lb. containers of Amdro® were available for $5 and $10, respectively, in a centralized neighborhood location. One homeowner made arrangements with a local retailer to purchase cases of product for resale to the neighborhood residents. Scotts® brand Easy™ Hand-Held spreaders were utilized to broadcast the bait over the lawns. Each homeowner was instructed to apply ~4 to 6 oz. of bait in their lawn and wait 3 to 5 days to spot-treat any nuisance mounds. Post-treatment mound counts and biological surveys were conducted at ~3 weeks, 6 months and 1 year. A survey was mailed to each homeowner soon after treatment to gather information on fire ant problems and expenditures prior to this program.

Countryside Neighborhood

Twenty-seven of the 190 homes in the neighborhood and one vacant "island" were randomly selected as sites for biological surveys and mound counts. Four small condiment cups were baited with small pieces of canned tuna, placed in a transect across the front lawn of each site and allowed to remain for at least 30 minutes before being collected and capped. Mound counts were taken for the entire lot. Shade cover and turf type were recorded for reference. In April of 1999, homeowner association board members elected to contract with a local San Antonio pest control company to perform a fire ant bait application on all front lawns in the neighborhood. The association contracted a $1200 fee with the pest control operator to broadcast ~5 oz. of PT® 370 Ascend™ Fire Ant Stopper® Bait (abamectin) in each front lawn with a commercial broadcast spreader. Homeowners were not directly charged for this service. Homeowners were asked to treat any new mounds individually as they appeared. Biological surveys and mound counts were conducted at 2 and 6 months post-treatment. A survey was mailed to each homeowner soon after treatment to gather information on fire ant problems and expenditures prior to this program.

Results/Discussion

Jade Oaks Neighborhood

Eighty-five of 91 possible homes participated in the September 1998 "Fire Ant Day." Reasons for non-participation are unknown. Pre- and post-treatment results of biological surveys and mound counts are displayed in Table 1. An average of 4.7 mounds per lawn were found prior to treatment and reduced to less than 1 mound per lawn at the 2-week post-treatment interval. Biological surveys prior to treatment trapped 5 species of ants including *S. invicta*. Post-treatment surveys captured 3 species of ants including *S. invicta* at the 2-week post-treatment interval and 2 native ant species (no *S. invicta*) at the 6-month post-treatment inspection. One-year surveys captured 5 ant species including *S. invicta* and a total of 3 mounds were counted in 15 survey lawns.

Countryside Neighborhood

Of 190 homes in the neighborhood, 187 participated in the April 1999 "Fire Ant Day." Participation in this effort was not 100% due to the fact that the neighborhood association did not notify residents prior to the treatment. Some residents refused to allow the bait applications in their lawns on treatment day. Pre- and post-treatment results of biological surveys and mound counts are displayed in Table 2. Pre-treatment surveys revealed 11 ant species including *S. invicta* and mound counts averaged 0.4 mounds per lawn in the 28 survey lawns. This in itself does not justify the broadcast application of bait insecticides for fire ants, but the association selected this method of application. The decision was made to proceed and document the results of treatment. Surveys at 2 months post-treatment trapped 13 ant species including *S. invicta* and mound counts averaged 0.1 per lawn in the 28 sites. Evaluations at 6 months post-treatment trapped approximately the same numbers of ant species including *S. invicta* but no mounds were seen in the 28 sites. This might partially have been the result of almost no rainfall in the San Antonio area from June of 1999 until evaluations in October 1999.

Treatment Costs

Potential costs of treatment by the homeowners that returned pre-treatment surveys might be reduced somewhat by these neighborhood programs. According to responses in Jade Oaks, 55.2% of respondents spent an average of $111.30 per year to control fire ants in their lawns prior to initiating this effort. By spending $5 to broadcast the Amdro® fire ant bait, these homeowners reduced their potential treatment costs by 96% over their previous expenditures. By contrast, 82.8% of homeowners in the Countryside neighborhood spent an average of $38.33 per year on fire ant treatment strategies prior to initiating their program. When dividing the initial contract cost of $1200 over the 187 participants in Countryside, I arrive at a per homeowner cost of $6.42 for treatment. This represented an 83% reduction in potential costs compared to previous expenditures. Actual costs after the initial treatments were unknown awaiting the results of post treatment surveys. Of 91 pre-treatment surveys mailed to Jade Oaks residents, 29 were returned (31.9%); Countryside residents returned 69 of 190 surveys that were mailed (36.3%).

Conclusion

Neighborhood programs for the treatment of red imported fire ant infestations have the potential to save money and reduce the amounts of pesticides that are applied. Not only does the amount of infestation in the neighborhood determine the treatment strategy, but it appears that the age and ecological structure of the neighborhood may also play a role in the success or failure of fire ant colonization efforts. Ecological stability, shade cover and lack of construction in older neighborhoods may play a role in the establishment of healthy native ant populations that, in turn, act to suppress and deter fire ant colonization efforts. On the other hand, newly constructed neighborhoods with ongoing construction, immature shade trees and newly sodded lawns provide the perfect elements for potentially dense fire ant populations: disturbance, ample sunlight, regular turf irrigation (moisture) and low native ant populations. With all of these things in mind, landscape and pest control professionals, extension personnel and others can provide guidance for homeowners regarding effective and efficient IPM programs to reduce the populations of red imported fire ants in their lawns and neighborhoods.

Acknowledgments

The author wishes to thank Mardell Murrow and Billy Lawton of the Jade Oaks neighborhood and Greg Asvestas of the Countryside neighborhood for their leadership in organizing local efforts in their areas. Thanks also goes to Bret Royal of American Cyanamid and Mark Krebs of Centex Hometeam™ Services for providing their services to these areas. A final word of thanks goes to Dr. Scott Cummings, Assistant Professor and Extension Program Accountability Specialist for analyzing the survey data from these neighborhoods and Dr. Charles Barr, Extension Program Specialist - Fire Ant Project, for his technical and tactical assistance with these programs.

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Lard, Curtis F., Charles Hall, and Victoria Salin. "Economic Impact of the Red Imported Fire Ant on the Homescape, Landscape, and the Urbanscape of Selected Metroplexes of Texas," final report to the Texas Imported Fire Ant Research and Management Plan, Fire Ant Economic Research Rpt. #99-08, Aug. 1999.

Table 1. Results of Pre and Post Treatment† Biological Surveys and Fire Ant Mound Counts in the Jade Oaks Neighborhood, San Antonio, Texas, 1998 - 1999.

		September 10, 1998		October 3, 1998		April 16, 1999		September 9, 1999	
Location	Turf Type	Ant Species	# of Ant Mounds	Ant Species*	# of Ant Mounds	Ant Species	# of Ant Mounds	Ant Species	# of Ant Mounds
1A	Xeriscape	**IFA**	5	None	0	None	0	BHA	0
1B	St. Augustine	**IFA**	3	None	0	None	0	None	0
1C	St. Augustine	None	6	None	0	None	0	None	0
1D	St. Augustine/Bermuda	None	5	None	0	None	0	None	0
1E	St. Augustine	**IFA**, PI	5	None	0	PI	0	PI	0
2A	St. Augustine	**IFA**, PI, PA	5	None	0	PA	0	PA	0
2B	St. Augustine	**IFA**, PA	6	None	0	None	0	None	0
2C	Zoysia "El Toro"	**IFA**, PA	6	None	0	None	0	**IFA**, PA	**2**
2D	Zoysia "El Toro"	PI	**2**	None	0	None	0	None	0
2E	Bermuda/Native	**IFA**, FS	5	**IFA**, FS	**3**	None	0	**IFA**, FM	**1**
3A	Zoysia "Emerald"	PI	3	**IFA**	0	None	0	None	0
3B	St. Augustine	**IFA**	4	None	0	None	0	None	0
3C	St. Augustine	**IFA**	6	None	0	None	0	None	0
3D	St. Augustine	**IFA**, BHA	5	None	0	None	0	BHA	0
3E	St. Augustine	**IFA**	5	None	0	None	0	None	0

* The names of ant species are abbreviated as follows: IFA = Red Imported Fire Ant (*Solenopsis invicta*); FS = Formica Ant (*Formica* spp.(*schaufussi*)); PI = False Honey Ant (*Prenolepis imparis*); PA = Pavement Ant (*Tetramorium caespitum*); FM = *Forelius mccooki*; BHA = Big-Headed Ant (*Pheidole dentata*)

† Initial treatment occurred on September 19, 1999.

Table 2. Biological Survey Results and Fire Ant Mound Counts Prior to and after Treatment Occurred On April 24, 1999 in the Countryside Neighborhood, San Antonio, Texas, 1999.

		Pre-Trt (4/21/99)		Post Trt (6/24/99)		Post Trt (10/29/99)	
Location	Turf Type	Ant Species*	# of Mounds	Ant Species	# of Mounds	Ant Species	# of Mounds
11	St. Augustine/Bermuda	BHA, AA	0	BHA, AA	0	BHA 2 spp, FHA	0
12	St. Augustine	BHA 2 spp , FHA, LBA	0	None	0	FM,AA, LBA,BHA	0
13	St. Augustine	None	0	FC, TA	0	BHA, FM, YPA	0
14	St. Augustine/Bermuda	BHA, FP, LBA	0	LBA	0	BHA 2 spp	0
21	St. Augustine	BHA, AA, FP	0	FP, LBA, BHA	0	BHA 2 spp, AA	0
22	St. Augustine	BHA, CA, FP	0	BHA, LBA	0	BHA 2 spp, FHA, **IFA**	0
23	St. Augustine	FHA, BHA, LBA	0	2 spp BHA, LBA	0	LBA, BHA 2spp	0
24	St. Augustine	AA, FHA, BHA	0	FHA, BHA	0	BHA 3 spp	0
31	St. Augustine	BHA	0	2 spp BHA	0	FM, FHA, BHA 2 spp	0
32	St. Augustine	FP, PA, BHA, FHA	0	PA, FHA	0	PA, BHA	0
33	St. Augustine	FP	0	FP, FHA	0	PA, BHA	0
34	St. Augustine	**IFA**, AA, FP	3	FP, BHA, LBA	0	FP, FHA, AA, BHA 2 spp	0
41	St. Augustine	BHA, FP, AA	0	BHA, FP	0	FP, BHA 2 spp	0
42	St. Augustine	**IFA**, BHA	2	FM, TA	0	FHA, BHA 2 spp	0
43	St. Augustine	FP, FC, BHA	0	BHA, FP	0	FP, FHA, BHA 2 spp	0
44	St. Augustine	2 spp BHA	0	**IFA**, FM, TA, LBA, FHA	2	LBA, BHA	0
51	St. Augustine	FHA, BHA	0	**IFA**, BHA, FHA, FP	2	**IFA**, BHA, FHA	0
52	St. Augustine	**IFA**, FHA	4	BHA	0	**IFA**, BHA 2 spp	0
53	St. Augustine	BHA, TA	0	TA, BHA	0	BHA	0
54	St. Augustine	FP, AA, BHA	0	AA, BHA	0	BHA 2 spp	0
61	St. Augustine	TA, BHA, FHA	0	BHA	0	BHA 2 spp	0
62	St. Augustine	BHA	0	AA, BHA	0	**IFA**, BHA, AA, FHA	0
63	St. Augustine	TA, BHA	0	FHA, BHA, LBA	0	BHA, 2 spp	0
64	St. Augustine	PA, FP, BHA	0	FP, BHA	0	BHA 2 spp, FP, FHA	0
71	St. Augustine	**IFA**, BHA	2	BHA	0	None	0
72	St. Augustine	FP, BHA	0	FM	0	BHA	0
73	St. Augustine	BHA	0	BHA	0	BHA 2 spp	0
74	St. Augustine	BHA, FHA	0	BHA, FHA	0	FHA, AA, BHA 2 spp	0

* The names of the ant species are abbreviated as follows: IFA=Red Imported Fire Ant (*Solenopsis invicta*); FHA=False Honey Ant (*Prenolepis imparis*); FM=*Forelius mccooki*; FP=*Forelius pruinosus*; PA=Pavement Ant (*Tetramorium caespitum*); BHA=Big Headed Ant (*Pheidole* spp.); LBA=Little Black Ant (*Monomorium minimum*); CA=Carpenter Ant (*Camponotus* spp.); AA=Acrobat Ant (*Crematogaster* spp.); TA=Thief Ant (*Solenopsis molesta*); YPA=Yellow Pyramid Ant (*Dorymyrmex insana*)

COMMUNITY-WIDE FIRE ANT MANAGEMENT IN DALLAS AND TARRANT COUNTIES, TEXAS: AN OVERVIEW

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Introduction

The red imported fire ant (*Solenopsis invicta* Buren) is the primary pest for which residents purchase pesticides. This pest creates problems not only when they sting people but also when they build unsightly mounds in lawns, gardens or electrical devices. Residents can be more effective at controlling fire ants and spend less money doing so if they work together to organize a community-wide fire ant management program. The Lakeview Country Estates Owners Association, (Mansfield, Tarrant County, Texas) is one example of such community-wide efforts. The Lakeview Owners Association is very active, hosting numerous neighborhood activities. These activities are often interrupted by fire ant stings.

In an initial survey 93.8 percent of respondents reported fire ants present in their lawns. Fifty percent reported fire ants to be a moderate problem and an additional 37.5 percent reported these pest to be a minor problem. Nearly sixty-three (62.5) percent spent money on fire ants and 37.5 percent treated at least once per month.

The objective of this project was to establish a community-wide fire ant management program, teaching residents better methods to control fire ants and thus reduce the economic impact fire ants have on the neighborhood as well as documenting the biological impact of community-wide fire ant management.

Materials and Methods

Leaders in the association obtained written commitments from 52 of the 54 residents. This commitment involves the local residents agreeing to work with Texas Agricultural Extension Service (TAEX) for a period of two years as a research project. The Extension Service provided educational training, biological assessment, planning and guidance in organizing the community-wide treatment effort. The local community then provided data by responding to survey documents prepared by TAEX and assisting in biological assessments. An educational meeting was arranged to provide information to the residents and answer questions. "This meeting was the best attended meeting of the association in years", commented Mrs. Lesa Spangler, former association president.

Biological assessment of the ant populations was documented on June 12,1999. Nine residents assisted with counting ant mounds if front lawns and collecting ant specimens for identification. Fifteen front lawns were inspected, average size was slightly less then 1/4 acre (9345.8 square feet). These lawns averaged 2.87 mounds each and a total of six species of "desirable" ants were collected. These "desirable" ants represent native or exotic species which may be good competitors of fire ants and their populations are worth preserving as a deterrent for fire ants.

Selected treatments were applied on July 10, 1999. Three different treatments were available to residents. Forty-two residents chose to broadcast Amdro® Fire Ant Bait (hydramethylnon) at the standard rate of 1 to 1.5 pounds per acre. Seven residents, who found few fire ant mounds present in their lawns, chose to treat individual ant mounds using Orthene® Turf Tree and Ornamental Insecticide (acephate). Treatments were completed by most residents by 11:00 A.M., later that afternoon there was a thunderstorm. Residents reported between one and one and a half inches of rainfall.

Ant populations were assessed again on September 14, 1999, after allowing sufficient time for the Amdro® to impact the ant colonies. At this time the same fifteen front lawns were surveyed for visible fire ant mounds and collections of ant specimens made. Lawns now averaged 2.0 mounds per lawn with desirable ants still present. The decision to apply a second treatment was made and this occurred on October 23, 1999. Thirty-one lawns were treated with Amdro® at that time. Biological assessment will be conducted again in the Spring of 2000.

Results and Discussion

Even after raining the same day that treatment was made using Amdro® Fire Ant Bait, the average number of fire mounds per front lawn was somewhat reduced. Participants also completed a post-treatment survey to assess resident perceptions. Fifty-six percent of the respondents reported an increase in knowledge of fire ant control and 94 percent rated the project as very valuable to extremely valuable. Seventy-eight percent of respondents reported fewer ants and an additional 78 percent reported fewer ant related problems.

In the Lakeview Country Estates Fire Ant Management project 83 percent of the respondents reported saving money. Fifty-six percent stated they would change their fire ant treatment methods and 100 percent reported that a community-wide fire ant treatment project is worth the time and effort.

Conclusions

Community-wide fire ant treatment, based on sound biological data, can reduce fire ant numbers, reduce cost to residents and reduce pesticide usage. This is an on-going project and will continue through the spring 2001 and will provide additional data during this time period. Additional community-wide treatment projects are underway and will provide added data.

Acknowledgments: Texas Agricultural Extension Service, Tarrant County gratefully thanks Mr. Bret Royal of the American Cyanamid Corporation for providing the Amdro® Fire Ant Bait for this project and to Pam Knoepfli of Valent Corporation for providing Orthene® TT&O for this project. Extension Agent Scott A. Russell also thanks Mrs. Lesa Spangler and the residents of Lakeview Country Estates for their work in organizing and implementing this community-wide fire ant management project. The author also wishes to acknowledge assistance from Extension Program Specialist, Dr. Charles Barr, TAEX, for technical guidance.

TRAVIS/WILLIAMSON COUNTIES' SHOWCASE PROGRAMS: AN UPDATE MT. BONNELL/COLORADO CROSSING HOMEOWNER ASSOCIATION AND APACHE OAKS NEIGHBORHOOD ASSOCIATION

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Introduction

The Mt. Bonnell neighborhood consisting of 137 homes is an on-going pilot fire ant management project that began fall 1998. Of data obtained from a post-treatment survey in fall 1999, 84 percent of the respondents have noticed fewer fire ants since the project's inception. The neighborhood is a dynamic area resulting in several residents being unfamiliar with the fire ant project from 1998. Informal surveys conducted by this Extension Agent suggest that homeowners have high interest in fire ant management, since the neighborhood has many young families with small children. Prior to this project, 34 percent of respondents rated their fire ant knowledge as 'low'. Survey results indicate that 67 percent rated the project as 'highly valuable' in terms of helping them understand better fire ant control.

Following an initial fire ant management presentation to the Apache Oaks Neighborhood Association by this agent on May 3, 1999, the residents decided to participate as a Apilot showcase@ demonstration for Williamson County. Their neighborhood was selected to develop documentation of the success of this fire ant management approach for use by other interested neighborhoods. In the Apache Oaks Neighborhood, critical data was obtained by monitoring imported fire ant populations and the presence of other ant species in yards. Residents were also surveyed to document pesticide use practice changes resulting from program participation, as well as the social and economic impact of fire ants on citizens in this urban neighborhood.

The Neighborhoods

Mt. Bonnell Subdivision was developed in the mid 1980's with several homes currently being built. It is located in west Austin bordered by Lake Austin on the west, with properties backing up to a tributary/greenbelt on the south. Lot sizes widely vary, so for the purpose of this study, random lots were selected and portions of those lots were measured and recorded using G.P.S. coordinates. The resulting lot dimension averaged 2,045 s.f. which contains either St. Augustine, Bermuda turf or mixture of the two, with part shade to sunny areas.

The Neighborhood of Apache Oaks of similar age as Mt. Bonnell, is located in eastern Round Rock off FM 1431, one mile north of Highway 79. There are 72 homes that comprise the subdivision and lot sizes are roughly 5,000 to10,000 square feet including the home. Turf on lots is St. Augustine, Bermuda or mixture of the two with sun to part shade.

Materials and Methods

Mt. Bonnell Neighborhood

One of the main concerns with the Mt. Bonnell neighborhood is the diverse ant population found coexisting with the red imported fire ant. Pre-treatment biological survey in Oct. 1998 had indicated there were five native ant species in addition to the most visible red imported fire ants. Homeowners were educated to this finding prior to the first treatment in 1998. Most chose to broadcast treat anyway, others used an individual mound treatment (acephate) in some areas, bait in others. A subsequent pre-treatment biological survey in October 1999 indicated there were seven native ant species in addition to red imported fire ants. As in 1998, homeowners were made aware of this fact and most chose to broadcast treat.

For each biological survey, bait cups were used consisting of a small amount of tuna with oil. Ants were captured and placed in one-dram vials for identification. Baits were donated in 1998 for incentive purposes by Novartis (Award®), Wellmark (Extinguish®), and American Cyanamid (Amdro®). The Mt. Bonnell Homeowners Association provided the hand-held seeder spreaders for the neighborhood to use. In 1999, Distance® Fire Ant was donated by Valent Corporation.

Apache Oaks Neighborhood:

Ant monitoring: Beginning on May 19, 1999, thirteen yards were selected at random for sampling imported fire ant populations and the presence of native ant species. Only front yards were used, and the average square footage of the area surveyed was 2,400. Imported fire ant mounds were counted and bait cups containing fish flavored cat food were placed in yards for less than 60 minutes to attract and collect any native or exotic ant species present. The first post-treatment ant mound counts were obtained on July 22, nine weeks after treatment, and ants were sampled using baited vials on September 1, 1999, 15 weeks after treatments were applied.

Treatment: The initial community-wide treatment date was May 22, 1999. Three fire ant bait products were donated for use in different yards, including: Award7 (containing fenoxycarb, similar to Logic7), Distance7 (pyriproxyfen), and a small amount Seige7 Pro (hydramethylnon, similar to Amdro7). Bait used in this demonstration was donated by the products= manufacturers, (see above credits).

Survey of residents: A six page survey developed by Dr. Charles L. Barr, Extension Program Specialist (see Appendix 1) was mailed to each homeowner two days prior to treatment day. Completed surveys were returned on the treatment date in exchange for a quantity of donated bait needed to treat participants= lawns.

Results/Discussion

Mt. Bonnell Neighborhood: (Table 1.)

During the 1999 treatment, 127 out of 137 homeowners participated in the 'treatment day'. Several television stations were present to interview homeowners and film them treating their yards. This is another focus of the pilot project – exposure. This neighborhood serves as a model for other neighborhoods and communities to emulate.

Objectives for the community-wide fire ant management program are:

- Provide education of usable and sustainable solutions for fire ant control,

- Educate homeowners in the proper use of fire ant pesticides and their effects,
- Decrease the impact of fire ants in the neighborhood, so children can play without being stung.

The post-treatment survey data can be used as a microcosm for other communities who implement the fire ant management program. Of the Mt. Bonnell residents who participated, 54 percent said they have already or will now change they way they control fire ants. Residents now expect to treat for fire ants in the fall. Ninety two (92) percent of the survey respondents noted that the neighborhood wide method of control is worth the time and effort.

Apache Oaks Neighborhood: (Table 2.)

Ant surveys: Prior to treatment, imported fire ant mound numbers ranged from zero to seven per yard with an average of 3.67 per yard (a total of 44 mounds in 31,172.6 sq. ft. total for 13 front lawns). Bait cup sample results documented that the red imported fire ant was the dominant ant species present prior to treatment. The nine-week post-treatment mound counts revealed that out of the 13 yards surveyed, four imported fire ant mounds total were found; averaging 0.33 per yard Thus, treatments and hot, dry weather resulted in a 91 percent reduction of ant mound numbers.

Post-treatment baited vial samples obtained September 1 clearly shows that the red imported fire ant (*Solenopsis invicta*) was considerably decreased, and that the native fire ant, (*Solenopsis geminata)*, became the dominant ant. This species that is not generally considered to be a serious pest ant species; its presence is actually thought to help in the fight against the imported fire ant by competing with it for food and nesting sites. Comments from Dr. Rich Patrock, of the University of Texas Brackenrige Field Lab, who identified the >post-treatment= ants, Athe recovery of the *geminata* following treatment is a very interesting finding...(but) diversity indices using ant counts are not reliable because of recruitment differences across taxa and the interaction of recruitment with timing of discovery by the ants and the timing of the bait checks. There was a gain in diversity once you removed *invicta* (mean of -0.385 but not a significant increase t of 1.05, p =0.316). The question I have now is where was the *geminata* before *invicta* were knocked out?@

Treatment: A participation rate of 95 percent was achieved; 68 out of 72 homeowners treated their yards, either themselves or using volunteers from the neighborhood association.

Survey of residents: Of all the surveys mailed to residents, thirty percent were returned. Participants reported spending an average of $40 (from $1 to $100 per year), on fire ant treatment products. The frequency of treatments ranged from two to four times per year to more than once per month.

As a result of the bait treatments, Apache Oaks homeowners spent considerably less to treat their lawns. Using approximately 50 pounds of bait product at a cost of ~ $400, homeowners will spend $6 (or $5-$10) per year to treat their neighborhood, for an average reduction of $34. Most homeowners will not spend much more than this figure, to support this data, there were not enough mounds to justify treatment for the fall.

Conclusions

These neighborhood projects will continue to be monitored through the Extension Service. The goal of the Texas Imported Fire Ant Research and Management Plan is to reduce fire ant populations to a level that eliminates this insect as a serious pest in terms of economic losses and health threats. Data confirms success of the *Two-Step* method encouraged by the Extension Service for controlling red imported fire ants, without sacrificing native or competitor ant species. Residents feel a sense of accomplishment for their efforts and plan to continue the program.

Acknowledgements:

Melanie Duck, Mt. Bonnell Association – thanks are not enough for her outstanding positive attitude and ever willingness to accommodate the needs of the Fire Ant Project. The author would like to thank Dale A. Mott, EA-IPM, Williamson Co. for his help with the Apache Oaks Project. Also, to Rody Best, Extension Associate, Fire Ant Project for his help in the Mt. Bonnell Project. As well thanks to Mike Sheppard, Apache Oaks Association President. A very special thanks to manufacturers reps for providing fire ant bait: Travis Klosterboer, Novartis Crop Protection, Inc., Pamella Knoepfli, Valent Professional Products, Doug VanGundy, Wellmark International, Bret E. Royal, American Cyanamid, for without their help these projects would not have been successful.

Table 1.
Mt. Bonnell Data: Mound Counts & Biological Surveys

Location	Sq. Ft.	#Mounds Pre 98 Treat	Ant Species* Pre- 98 Treat	# Mounds Post-98 Treat	Ant Species* Post-98 Treat	Ant Species Pre-1999 Treatment
1	2,034.4	5	SI,MM,P	0	MM,	SG,MM,PL,
2	2,757.5	7	SI,MM	1	MM	MM,PV,P
3	2,516.2	14	SI,F	0	MM	CL
4	3,672.4	4	SI	0	MM,PV	SI,MM,F
5 (c)	4,671.6	15	SI,MM,F	2	SI,MM	SI,MM,F
6	2,226	1	SI,MM,P,PV	0	MM,CL	MM,P
7	2,210.5	0	SI,P	0	MM,PV,P	PV,P
8	4,266	4	SI,MM	1	SI,PV	P
9	1,599.5	3	SI,P	0	SI,CL	PV
10	1,199	6	SI,PV,P,MM	3	SI,CL	SI,MM,PV
11	2,770	0	MM	0	SI,MM	SI,MM,PV
12	1,608.4	4	SI,MM	0	MM,CL	SI,MM,CL
13	1,534.4	1	SG	0	SI,MM	MM,PV
14	922.8	2	SG,PV	2	SI,PV	MM,P
15	469.7	1	SI	1	MM,	MM
16	2,337.6	1	MM,P	0	PV,CL,P	MM,PV,P
17	1,552.9	5	SI,P,PV	0	MM,PV,CL	SI,MM,P
18	1,084	3	SI,PV	0	SI,MM,PV,CL	SG,MM,PV
19	1,724	0	PV,P,MM	0	MM	MM,PV,CL
20	748.1	1	SI	1	SI,PV	MM,PV,P
21	1,212.4	0	--	0	SI,PL	SI
22	1,713	1	SI	1	MM	MM,PV
23	3,033	5	PV	0	SI	SI
		Tot: 83		Tot: 12		
		Avg:3.78		Avg: .52		

*Species of ants abbreviated as follows: SI-Red Imported Fire Ant (*Solenopsis invicta*), MM-Little Black Ant (*Monomorium minimum*), SG-Native Fire Ant (*Solenopsis geminata*), P-Big-Headed Ant (*Pheidole spp.*), PV (*Paratrechina vivdula*), PL (*Paratrechina longicornis*), CL-Acrobat Ant (*Crematogaster laeviscula*) F (*Forelius foetidas*)
(c) Control

Table 2.
Apache Oaks Data: Mound Counts and Biological Surveys

Location	Sq. Ft.	#Mounds Pre-Treat	*Ant Species Pre-Treat	#Mounds Post-Treat	Ant Species Post-Treat
1	5383.2	4	SI,PV	1	SI
2	1112.2	4	SI,PV	0	SI,PV,CC
3	711.8	3	PV,BD	0	PV,SG
4	4448.9	2	SI,PV	0	SI
5	711.8	3	SI,PV	0	SI
6	3214.3	0	SI,PV	0	PV,SG,FM
7	1601.6	3	SI	0	--
8	1112.2	0	--	0	PV
9	5383.1	7	SI	1	PV,SG
10	3603.6	5	SI	0	SG
11	1879.7	2	SI	1	PV,SG
12	1112.2	7	SI	1	SG
13	900.0	4	SI,PV	0	PV,SG
		Tot: 44		Tot: 4	
		Avg: 3.67		Avg: .33	

* Species of ants abbreviated as follows: SI- Red Imported Fire Ant (*Solenopsis invicta)*, PV- (*Paratrechina vivdula),* SG- Native Fire Ant (*Solenopsis geminata)*, FM- (*Forelius mccooki),* CC- (*Crematogaster cerasi),* BD- (*Brachymyrmex depilis)*

THE CURRENT STATUS OF THE RED IMPORTED FIRE ANT CONTROL PROGRAM IN EL PASO, TEXAS

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ABSTRACT

The red imported fire ant has been in the El Paso area for about 10 years. There were initially 4 isolated populations. We are experimenting with various insecticides and with ant predation on the founding queens of this pest. We have possibly eliminated one of the populations and greatly reduced a second population. Apparently it is possible to eliminate the red imported fire ant in newly invaded areas with isolated populations.

INTRODUCTION

The red imported fire ant was reported from the El Paso area in 1997, although it was probably introduced 10 years earlier (Mackay and Fagerlund, 1997). This species was reported from 3 separate areas in El Paso (Moreno et al., 1999), and was found in a fourth area in the summer of 1999. Nest densities ranged from a few nests, up to 40 nests per acre. We are currently attempting to eradicate these populations with insecticides. We are also interested in using small, predaceous thief ants to eliminate founding queens. In this report, we discuss the results of our attempts to control this pest and the future directions of our research.

METHODS AND MATERIALS

Our principal objectives are identifying populations of the red imported fire ant in southwestern United States, and eliminating the populations while they are small and isolated. We use a standard technique to sample fire ants (Moreno et al., 1999). The method consists of placing 10 surface baits at each randomly selected location. Each bait consists of a piece of tuna flavored Tender Vittles® cat food, placed in a 1 ounce Dixie® condiment cup. Five baits are placed in the front yard of a home, 5 baits in the backyard. In desert areas, we place 5 baits on each side of a road or trail. The baits are collected 30 minutes after placement of the bait, capped, placed in a cooler, and later frozen in the laboratory.

We also establish subterranean traps baited with live mealworms, to sample potential predators of the founding queens of the red imported fire ant.

We are attempting to control the ants using the insecticides Logic® and Amdro®. We are following the manufacturer's instructions in treating the mounds, and in broadcasting the baits in heavily infested areas.

Predation on fire ant queens is currently being studied under laboratory conditions. Thief ants (primarily *Solenopsis krockowi*) are collected in subterranean baits, and maintained under laboratory colonies. Native fire ants (primarily *Solenopsis xyloni*) are collected with soil, and separated from the soil in the laboratory. Imported fire ants are collected in buckets and flooded in the laboratory. Predation experiments involve placing the virgin queens in small boxes with various numbers of foragers, to evaluate the effectiveness of the predators.

We have known of the potential use of tiny thief ants for fire ant control for many years. Unfortunatelly, much research with small thief ants is impossible due to the difficulty of identification. We are attempting to revise the thief ants of the United States, and possibly of the New World, in order to exploit these ants as predators on the founding queens of the red and black imported fire ants.

RESULTS

Apparently the red imported fire ant has been eliminated at one of the locations of infestation: the campus of the University of Texas at El Paso. We have eliminated the ant in most of the area of the second location, the Chamizal National Memorial. Mounds were especially dense in the bowl area (Fig. 1). There were 22 mounds still present in the bowl area, but they were treated in the fall of 1999. We anticipate eliminating this pest at the second location during 2000. The third and fourth sites are much more extensive, and may consist of a single large population. These populations are in a residential area, and elimination is expected to be difficult.

Figure 1. The distribution of large (> 15 cm diameter) red imported fire ant mounds in the bowl area of Chamizal National Memorial before treatment.

We were able to eliminate the population on the campus with repeated individual mound treatments. The nests at the Chamizal National Memorial were more difficult to control. The bowl area is the most heavily used, and had the highest nest density. We retreated individual mounds several times, and broadcast baits on the area once. Nest density has been greatly reduced (Fig. 2).

The thief ant, *Solenopsis krockowi*, has not been as effective as we had hoped. Large numbers of workers (over 100) are needed to destroy a female. This may not be as large of problem as it appears, since the Chamizal National Memorial has several thief ant nests per square meter, and each nest contains hundreds of workers. Thus the natural populations may be high enough to eliminate all or at least most of the new nests.

The native fire ant, *S. xyloni,* has been very efficient in eliminating imported fire ant queens in the laboratory, even in when relatively small numbers of ants are present.

DISCUSSION

We have been very successful in eliminating the red imported fire ant from some of the infested areas in El Paso. Our success is due in large part to our situation. The populations are restricted to urban habitats, and are not found in the surrounding desert. Additionally, we are attacking the populations when they are very small, and have not spread even into adjacent areas. It is important to establish a control program in the southwestern part of the United States before the populations of this pest become too large.

Constant vigilance will be necessary to discover new infestations and detect small infestations that have not been detected. Areas where control has been achieved will have to be sampled for several years to be sure the population has actually eliminated.

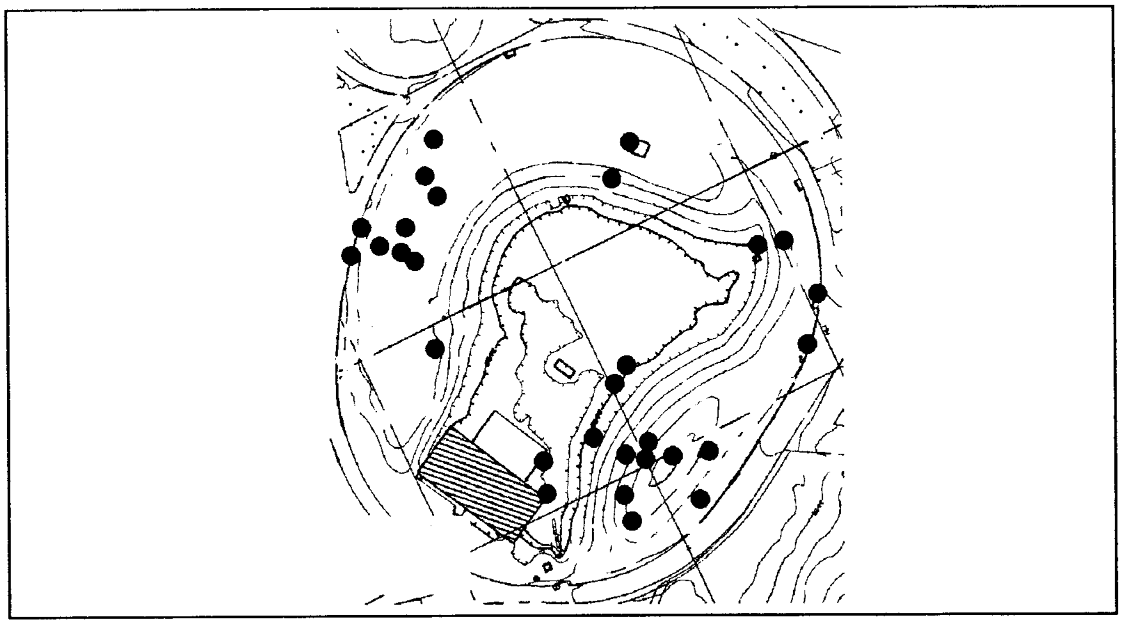

Figure 2. The distribution of large (> 15 cm diameter) red imported fire ant mounds after insecticidal treatment.

We plan to eliminate the 3 remaining populations of the red imported fire ant in El Paso. Hopefully we will eradicate the population at Chamizal National Memorial during the summer of 2000. We will continue our research on the effect of predation on the queens by thief ants. We may be able to modify the habitat to increase the numbers of thief ant nests. We hope to have completed a preliminary review of the thief ants of the United States by the end of the year. We are presently defining species complexes. We hope to find other species of predators, especially other ant species, or even mites. We know that there are mite species which attack the founding queens. If we can develop techniques to eliminate founding queens and eliminate established populations, we may be able to maintain El Paso fire ant free. If we are successful, we hope that our program can be a model for the remainder of the arid southwest.

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AREA-WIDE BAIT TREATMENTS COMPARED WITH INDIVIDUAL HOME-OWNER TREATMENTS FOR RED IMPORTED FIRE ANT MANAGEMENT

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Introduction

In the past 10 years there has been increased interest in area-wide insect pest management (Senft 1995, Calkins 1997, Chandler and Faust 1997, Comis 1997, Landis and Marino 1999). Historically, treatments of large areas or entire communities for red imported fire ant, ***Solenopsis invicta*** Buren, control has been associated with aerial distribution of Mirex in southern infested states. Recently, new, less toxic chemistries for baiting have allowed area-wide red imported fire ant management using broadcast baits to gain a new popularity and many southern states have implemented community-based programs.

Specifically, area-wide fire ant management strategies have included broadcasting an insecticidal bait followed by individual mound treatments with a contact insecticide a few days later (TAMU Technical bulletin). Although this strategy and others are well developed and are widely used in the southern states, area-wide ant management techniques have remained untested in urban areas, especially for control of red imported fire ants. In this study, we tested the community-based or area-wide fire ant management technique and compared it to individual homeowner efforts using broadcast treatment of baits.

Materials and Methods

We tested three insecticidal baits in an broadcast in an area-wide manner and on a smaller scale at individual residences. We randomly assigned the three bait treatments, Amdro, Award, and Distance to three replicate houses within each treatment area. A 40 hectare subdivision of Baton Rouge, LA (East Baton Rouge Parish) (=Spanish Town) was chosen for the area-wide baiting campaign. The residents of Spanish Town broadcast the baits throughout the entire neighborhood on "Put The Fire Out" day in April 1999. That same month, nine individual residences, also in Baton Rouge, were broadcast with bait by a professional pest control operator. Three residential properties were used as untreated controls for the individual effort and three large areas of interstate right-of-way were used for the area-wide untreated control.

Ants were monitored in treated and untreated areas prior to treatment and monitored monthly after treatment using two methods. First, we counted active fire ant mounds on each of the replicate properties. Second, we placed four food traps in the front and back yards of nine individual houses and nine houses that were within the designated area-wide treatment area. These food traps consisted of honey, peanut butter, Vienna sausage, and an ant diet that is attractive to many species of ants (Hooper and Rust 1997) which were left out for 2-4 hours. The food traps were collected and the ants were trapped inside and brought back to the laboratory and frozen. All ants were separated from the food traps, placed in 70% ethanol, identified, and counted.

An additional area-wide treatment was performed by the Spanish Town residents in October 1999 to maintain ant suppression. We stopped measuring ant populations on the individual properties after six months but continued to monitor the ants in the area-wide treatment area.

Results and Discussion

Individual Treatments. Red imported fire ants were suppressed at all sites with broadcast bait treatments when compared to the untreated controls. Individual treatments suppressed fire ants for ~2 months after which the number of mounds began to increase to pretreatment levels. Properties treated with Amdro and Distance had significantly less mounds than the untreated control (**P** = 0.05 and 0.04, respectively) until the last month of the study. Properties treated with Award had significantly less mounds than the control for the first three months but then the number mounds increased to surpass that of the controls (Figure 1). The increase in number of mounds during subsequent months is likely due to movement of colonies into the treated yards from neighboring untreated yards.

Area-wide Treatments. Area-wide treatments in April and October 1999 resulted in a radical reduction of the average number of fire ant mounds for 10 months (**P** = 0.001; Figure 2). Amdro, Award, and Distance all significantly reduced the number of mounds in the treated area (**P** = 0.0001, 0.001, and 0.01; respectively). Although there were no mounds in the area-wide treated yards from month 2 to 9, we still found fire ants in our food traps. Prior to treatment, we had 6729 red imported fire ants in 127 traps (avg. = 53 ants/trap). Two months post-treatment, we had an average of 30 ants in 29 traps (total ants = 809). The fact that observed no mounds in the treated yards and still captured fire ants underscores the importance of trapping in addition to mound counts to accurately determine treatment effect.

Area-wide treatment of red imported fire ant is much more efficacious than control efforts at the individual homeowner level when baits are broadcast. This is likely due to the movement of fire ant mounds from untreated neighboring yards into the "ant-free zone" that is created with baits broadcast on a smaller scale. The long-term fire ant suppression achieved through area-wide management demonstrates the effectiveness of baits in fire ant control. These data indicate that large areas treated with baits may be necessary to reduce the effect of the movement of ants into untreated areas.

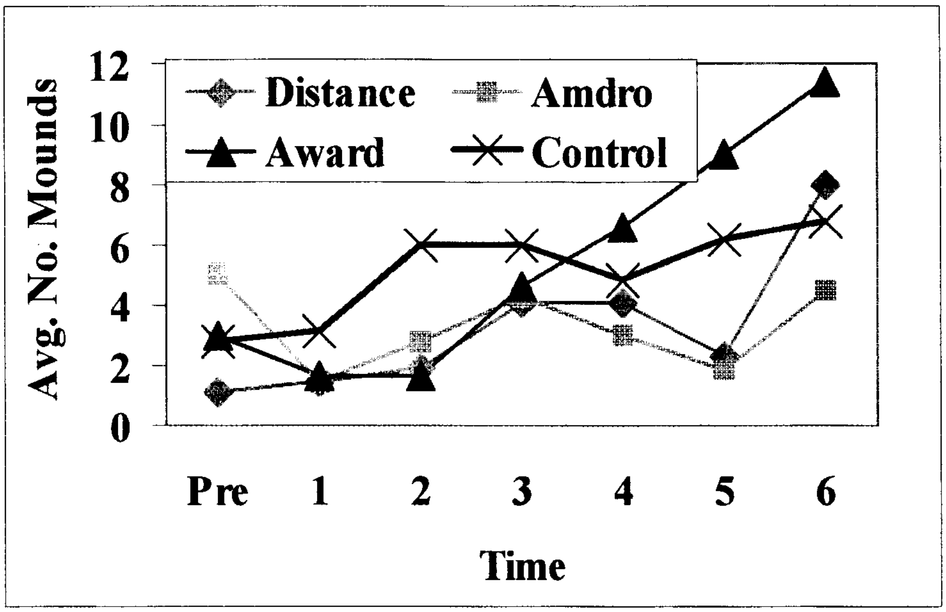

Figure 1. The average number of mounds seen per month at the treated and control individual residences.

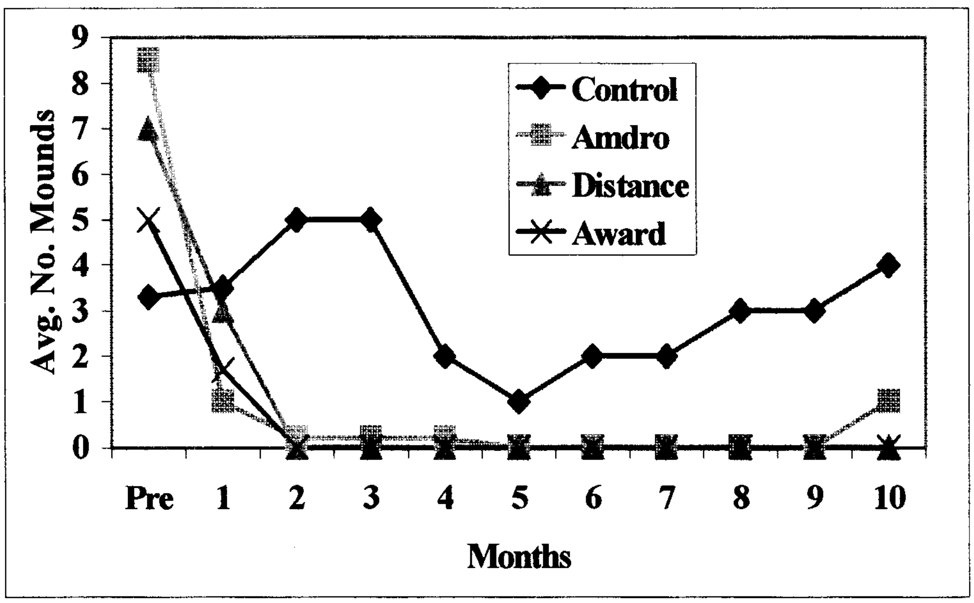

Figure 2. Average number of mounds counted per month per replicate residence in the area-wide treatment area.

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I. UPDATE ON *THELOHANIA SOLENOPSAE* INOCULATION AND INFECTION STUDIES
II. SEQUENTIAL APPLICATION OF INSECT GROWTH REGULATING AND METABOLIC INHIBITING FIRE ANT BAITS

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I. Update on *Thelohania solenopsae* inoculation and infection studies.

Field inoculations of the rnicrosporidium, *Thelohania solenopsae* were made, in1998, in 10 southern states [AL, AR, FL, GA, LA, MS, NC, OK, SC, & TN] to assess the impact of *T. solenopsae* on fire ants under different climatic conditions. In 1999, infections have been detected in 7 of these states [AR, AL, FL, GA, LA, MS, NC], however spread of infection has been limited. *T.* solenopsae infections in the field have typically been found in polygyne populations. Infections were detected in an inoculated monogyne site located in Florida. Inoculations were made to 5 colonies in July 1998, and in July and November 1999, infections were detected in 2 and 6 non-inoculated colonies, respectively.

Nearly 3 years of monitoring an inoculated polygyne field site in Florida, T. *solenopsae* infections have spread to over 85% of the fire ant nests sampled. Fire ant populations at this site have fluctuated, with a maximum decrease of 62%.

To further assess the host range of *T.* solenopsae, colonies of the southern fire ant, Solenopsis *xyloni*, which is a pest of almonds, were inoculated with red imported fire ant brood infected with *T. solenopsae*. After 12 weeks, colony infections were not evident, but this study is still in progress.

T. solenopsae spores were detected in 93% of the male alates (n=45 from 7 colonies) and 75% of female alates (n=133 from 9 colonies) initiating mating flights from infected colonies. Infections were also detected in 14 field collected, newly mated queens. Adult workers were produced by 9 of these queens. All infected queens died, with an average life span of 61 days (range 26-135 d).

II. Sequential Application of Insect Growth Regulating and Metabolic Inhibiting Fire Ant Baits.

Recent increases in the number of commercially available fire ant baits have resulted in an increase in control options and strategies. Most fire ant baits contain either insect growth regulators (IGRs) or metabolic inhibitors (MIs) as their active ingredient. IGR bait distribution has been shown to be more extensive among multiple colonies of polygyne/polydomous ant species such Pharaoh ants, *Monomorium pharaonis*, and polygyne fire ants. Thus, a laboratory study was conducted to determine if red imported fire ant, *Solenopsis invicta*, colonies that initially foraged on an IGR bait would forage on a subsequent application of a MI bait. IGR fire ant baits containing either methoprene (Extinguish) or fenoxycarb (Award) were provided to monogyne *S. invicta* laboratory colonies. A week later a MI bait containing hydramethylnon (Amdro) was provided to the same colonies. These treatments were compared to sole access of IGR and MI baits, and a control. All bait types contained a lipid based attractant. Treatments containing the MI bait, either solely or after IGR access, resulted in over 90% reductions in workers and brood, and queen death within 3 weeks of MI access. Sole access to the fenoxycarb and methoprene baits resulted in >90% control of workers and brood by an average of 14 and 20 weeks, respectively. Queen death ranged between 5 and 14 weeks in the fenoxycarb treatment, and from 8 to 24 weeks with the methoprene bait. The application of an IGR bait one week prior to MI access did not inhibit subsequent foraging and efficacy of the MI bait. Field studies are being scheduled to confirm these results and to determine any significant control advantage using this strategy for polygyne fire ant populations.

THE FIRE ANT MICROSPORIDIAN PATHOGENS *THELOHANIA SOLENOPSAE* AND *VAIRIMORPHA INVICTAE*: FIELD HOST RANGE, INTRACOLONIAL PREVALENCE, AND DUAL INFECTIONS

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The microsporidium *Thelohania* solenopsae (Microsporida: Thelohaniidae) is a common disease on indigenous populations of fire ants in South America (Allen and S. Guido 1974, Briano et al. 1995c). Its impact on fire ants was studied in Argentina and in the United States (Briano et al. 1995a, 1995b, Briano et al. 1996, Williams et al, 1997, Briano 1999, and Williams et al. 1999). T. ***solenopsae*** is being evaluated for the biological control of the imported fire ants in the United States (Williams et al. 1999).

Vairimorpha invictae (Microsporida: Burenellidae) is a rarer infection of fire ants in Argentina (Briano et al. 1995c) and nothing has been documented about its actual impact on fire ants.

Field Host Range of *Thelohania solenopsae*

A field host range study of ***Thelohania solenopsae*** was conducted intermittently from February 1994 to November 1999. Surveys were conducted at 38 preselected sites infected with *T.* ***solenopsae,*** in Buenos Aires and Santa Fe Provinces. In each site, 10 baits were placed at 10-m intervals. The baits (open 7-ml glass vial containing a small piece of Vienna sausage) were left on the ground surface for 30-60 minutes and ants collected were preserved in 70% ethanol for disease diagnosis and taxonomic identification. In addition, workers from leaf-cutting ant colonies and other fire ant nests visually detected in the vicinity of the sites were sampled and preserved. In the laboratory, a total of 505 samples was ground up individually and examined under phase-contrast microscopy (400x) for the presence of spore masses of ***T. solenopsae.*** The ant genera collected/sampled (and sample size) were: ***Solenopsis*** **(351)**, ***Pheidole*** **(57)**, ***Acromyrmex*** (20), ***Crematogaster*** (15), ***Wasmania*** (1), ***Camponotus*** (34), ***Prenolepis*** (2), ***Brachymyrmex*** (1), ***Linephithema*** (13), *Conomyrma (2)* and others undetermined (9). *T.* ***solenopsae*** showed high genus-specificity since it was found only in ***S. richteri*** **(26%)**, *S.* ***invicta*** (13%) and ***Solenopsis*** sp. (17%).

Abundance of *Vairimorpha invictae*

The prevalence of the microsporidium ***Vairimorpha invictae*** in fire ant colonies in Argentina has generally been much lower than *T.* ***solenopsae.*** However, in 1988 certain areas of Buenos Aires Province (Isla Talavera and Saladillo), *V.* ***invictae*** infected up to 60% of the colonies of ***S. richteri*** (Briano et al. 1995c). Within the last decade, it has been extremely hard to find a population of fire ants infected with this microsporidium, and has thus hindered investigations. Since 1995, locating high numbers of *Vairimorpha*-infected colonies was a high priority at the SABCL. Intensive field surveys were conducted in north-central Argentina. A total of 2,287 fire ant colonies was sampled in 144 collecting sites of 5 provinces, mostly along roadsides. Workers (100 to 5,000) from each colony were sampled by inserting a 7-ml vial into the fire ant mounds. The vials were dusted with talc to prevent the escape of ants. Samples were preserved in 70% ethanol or frozen until examination. In addition, hexane samples were taken in some sites and gas chromatography analysis was conducted at the USDA-ARS-CMAVE-Gainesville, FL, to confirm the presence of *S. invicta*. In the laboratory, most of the workers were ground up with water with a tissue grinder and a drop of the aqueous extract was examined under phase-contrast microscopy (400x) for the presence of spores of *V. invictae*. The remaining workers were preserved for identification.

The microsporidium *V. invictae* was found only in 54 (2.4%) colonies among 18 sites. The highest infection levels (23 to 35%) were found in April 1999 from two sites in Santa Fe Province. This was the first time *V. invictae* was found infecting colonies of *S. invicta* at these levels. However, subsequent surveys in the same sites revealed that the presence of infected colonies decreased to 7% in July 1999, and 13% in November 1999 and February 2000.

Intracolonial prevalence of *V. invictae*

Intracolonial prevalence of *V. invictae* was studied in 12 colonies of *S. invicta*. Individuals of all castes were examined: 315 eggs, 107 larvae, 58 pupae, 303 workers (50 dead individuals), 29 sexuals, and 3 queens. In immature ants, diagnosis of the infection was made by examining fresh Giemsa-stained smears of whole specimens (phase-contrast microscopy 1000x). In adult ants, infections were determined by examining whole individuals in aqueous extract for the presence of internal spore masses (phase-contrast microscopy 400x). Meiospores and free spores of *V. invictae* were quantified in workers and sexuals (n=34) by extracting them in 1 ml of water with a tissue grinder and counting them with a hemocytometer (phase-contrast microscopy 400x). Preliminary results indicated that: (1) both types of spores were present in larvae, pupae, and adult ants (workers, sexuals, and queens); (2) vegetative stages were present in larvae and pupae; (3) eggs were apparently uninfected, but the presence of spores in queens suggests that vertical infection might occur; (4) the prevalence of *V. invictae* was 100% in some colonies; (5) the number of meiospores and free spores ranged from 2.5×10^2 to 5.4×10^5/ml and from 2.5×10^2 to 6.5×10^4/ml, respectively; and (6) in some colonies 2 weeks after field collection, the prevalence of the infection in workers declined to <10%, however, 85% of the dead ants were heavily infected. This potentially indicates that fire ants infected with *V. invictae* have high mortality rates and reduced longevity.

Dual infections

Fire ant colonies infected simultaneously with *T. solenopsae* and *V. invictae* were observed for the first time at the SABCL in March 1990 from 2 declining colonies of *S. richteri* and 1 of *S. macdonaghi* maintained under laboratory conditions. After this observation, dual infections were suspected to be highly pathogenic to fire ants, but this assumption has never been documented. Dual infections in fire ant colonies have been rarely found in the field. During the surveys mentioned above, only 7 (0.3%) dual-infected colonies, 3 of *S. invicta* and 4 of *S. richteri*, were found in Santa Fe and Entre Rios Provinces respectively.

The intracolonial prevalence of dual infections was studied in two *S. invicta* colonies collected in Santa Fe. Diagnosis of both diseases was conducted, following the procedures described above for *V. invictae,* in 245 eggs, 54 pupae, 75 workers (20 dead workers), 24 sexual females and 3 queens. Preliminary results showed that dual infections were present in 41% of the pupae, 11% of the workers, 20% of the dead workers, and 4% of the sexuals.

Pilot tests are being conducted at the SABCL to artificially initiate dual infections. In July 1999, several hundreds workers from a queenless colony of *S. invicta,* infected with *V. invictae,* were transferred to a monogyne *S. invicta* colony infected with *T. solenopsae* (test colony). A similar number of workers was transferred to a control colony free of infection. Two months later, the colonies were examined at 3-week intervals by selecting 10-30 workers at random and examining them individually under a phase-contrast microscope for the presence of spore masses. Also, immature stages (n=170) were examined when available by examining fresh Giemsa-stained smears of whole specimens (phase-contrast microscopy 1000x). Results, so far, revealed that: (1) in the test colony, the prevalence of *V. invictae* in the worker caste has increased up to 90% of the workers; (2) workers exclusively infected with *T. solenopsae* were detected at the beginning of the test only in 5 to 10% of the workers; (3) dual infections were present in 10 to 70% of the workers; (4) no signs of infections have been detected in immature ants; (5) in the control colony, only 3.3% of the workers were infected with *V. invictae* in the initial examination and no prevalence of the infection was detected afterward.

Although the mechanisms of worker to worker infection remained unknown, it appeared that workers infected with *T. solenopsae* were more susceptible to infection by *V. invictae* than uninfected workers. However, the fact that immature stages have not become infected makes it uncertain whether *V. invictae* infection will perpetuate within the test colony. This is under further investigation.

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THE FIRE ANT PARASITE *SOLENOPSIS DAGUERREI*: PROGRESS REPORT AT THE USDA-ARS-SABCLARGENTINA

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The parasitic ant, *Solenopsis daguerrei* (Santschi) has been considered a potential candidate for the biological control of imported fire ants since the 1970's (Lofgren et al. 1975, Jouvenaz et al. 1981, Jouvenaz 1983 and 1990). Its presence was surveyed in South America and some detrimental effect has been documented on populations of the native fire ant *S. richteri* in Argentina (Bruch 1930, Silveira-Guido et al. 1973, Briano et al. 1997, Calcaterra et al. 1999).

Field host range

Field host range studies were conducted by examining numerous ant colonies in San Eladio, Buenos Aires Province, Argentina. This is the only field site where *S. daguerrei* has been found consistently since 1995. A total of 4,316 ant colonies of 9 species and 4 subfamilies were visually examined for the presence of the parasite. However, 96% were colonies of fire ants which are the predominant ants of the area. Other species found and examined were: *Pheidole bergi* Mayr, *Acromyrmex lundi* Guerin, *A. ambiguus* Mayr, *Camponotus punctulatus* Mayr, *Neivamyrmex pertyi* Shuckard, *Linepithema humile* Mayr, and *Brachymyrmex* sp. *S. daguerrei* was found exclusively parasitizing 3.9% of the fire ants *S. richteri* Forel and *S. quinquecuspis* Forel. *S. quinquecuspis* is reported for the first time as host for *S. daguerrei*.

Newly mated queens

Twelve colonies of *S. richteri* parasitized with *S. daguerrei* were collected in San Eladio in buckets coated with talc, brought to the laboratory, and placed in a plastic greenhouse. With appropriate weather conditions (24-33°C and high RH), 568 *S. daguerrei* sexuals were captured with an aspirator after they naturally flew out of the host colonies. From them, 97.5% were females and 81% lost their wings immediately after capture. Some were dissected (n=169) and insemination was confirmed in 84% of them. After several weeks, the colonies were separated from the soil by flotation and the remaining *S. daguerrei* females were dissected. Only 32% of were inseminated. We conclude that *S. daguerrei* mates within the host nest and mostly inseminated females fly from the host colony.

Process of Parasitism

The natural mechanism through which *S. daguerrei* enters a new fire ant host colony is unknown. Many tests were conducted to artificially parasitize *S. richteri* colonies but none were successful. Queens, sexuals, and pupae of *S. daguerrei* were transferred to nonparasitized colonies under different temperatures (10, 15 and 30°C). Survival of introduced parasites ranged from a few hours to one week. In April 1999, we captured 150 newly-mated *S. daguerrei* queens from colonies kept in the greenhouse and introduced them in several parasite-free colonies of *S. richteri*. The parasite newly-mated queens encountered the host queens very rapidly and yoked them, but none of the introduced queens survived for more than a few hours.

Similarly, in February 2000, we captured 245 *S. daguerrei* females from colonies kept in the greenhouse as above. Some (n=36) were dissected and insemination was confirmed in 78% of them. A total of 209 *S. daguerrei* females was introduced into 3 colonies of *S. invicta* and 2 of *S. richteri* and kept in darkness at 15°C. After one week, 2 colonies were moved to ambient temperature (24°C). Preliminary results indicated that: (1) In 4 of the 5 test colonies, several queens of *S. daguerrei* encountered the host queens very rapidly and yoked them, (2) The parasite queens not yoked to any of the host queens were killed immediately, (3) Mortality of the parasite queens was 88% by day 7th and 100% by day 12th. Although none of the introduced parasite queens survived for long periods, we speculate that, if eggs were laid by them before being killed, this F1 generation would be "accepted" by the host colony and will initiate parasitism. These colonies are being reared to monitor the emergence of the parasite.

Studies are underway to determine if different levels of intraspecific aggression in fire ant colonies (parasitized versus nonparasitized colonies) have any effect in the acceptance and propagation of *S. daguerrei*. Preliminary results showed that fire ant colonies parasitized with *S. daguerrei* are less aggressive than nonparasitized ones. The reason for this is not understood. It is essential that we understand the mechanisms by which *S. daguerrei* enters and parasitizes fire ant colonies before this parasite can be introduced into the United States as a biological control agent for imported fire ants.

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A FIELD COMPARISON OF FIVE BROADCAST BAITS AS FULL RATE, HOPPER BLEND AND SKIP-SWATH APPLICATIONS

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Introduction

A number of conventionally-formulated broadcast baits have been introduced to the market in the last few years for the control of red imported fire ants (Solenopsis invicta Buren). The Texas Agricultural Extension Service's Fire Ant Applied Research Program has tested most of the active ingredients in field tests over the years, but has never conducted a large-scale, replicated test of the more readily available ones at the same time. Past research has also shown that a 50:50 hopper blend of hydramethylnon bait (Amdro®) plus an insect growth regulator (IGR)-based bait yields the fast speed of suppression of hydramethylnon plus the long duration of control characteristic of the IGR baits. Again, the combination has been tested with several of the products, but not all of them, and not in the same test. Similarly, the effectiveness of skip-swath application of baits has been shown to vary, depending on the bait. This method of application has not been tested on all the products, either, Skip-swath application, when fully effective, provides similar control to full-rate, full-coverage treatments using half the product and half the labor.

Therefore, this test was designed to:

a) compare the speed, maximum effectiveness and duration of control of five conventionally-formulated broadcast baits when applied according to label directions;
b) compare the speed, maximum effectiveness and duration of control of four slow-acting baits when combined with hydramethylnon bait in a 50:50 hopper blend (1.5 lbs. total product per acre) and;
c) compare the speed, maximum effectiveness and duration of control of all five baits when applied in alternating 30-foot swaths.

Materials and Methods

The site selected for the test was the Palestine Municipal Airport in central East Texas. The airport consists of several hundred acres surrounding 5,000 and 4,000-foot runways set at right angles to each other in a cross-like configuration. The site also has numerous taxiways and other paved areas. Soil consisted of deep sand over most of the site, changing to reddish clay and gravel within 10-50 feet of pavement. The majority of visible fire ant mounds were located in this heavier soil. Many other fire ant colonies seemed to be present in the sandy areas, but their mounds were diffuse and difficult to locate and define under even the best conditions.

Plots dimensions were 300 x 150 feet (1.03 acres). To equalize the better mound formation conditions, all plots had one 300-foot dimension located along a paved surface. Plots were established 10 June 1999. With a few small gaps at the runway ends and to avoid overlapping at corners, plots completely lined both sides of the full length of both runways, all taxiways and several other paved surfaces around hangers and roads.

Sampling was accomplished with two people linked together with a 20-foot piece of rope so they effectively surveyed a swath width of 30 feet. One edge ran along the pavement to take advantage of the more easily visible mounds and frequently-mowed vegetation. The sample swath began 20 ft. from the plot end markers to provide a treated buffer between sample swaths. Therefore, total sample area was: 260 x 30 = 7800 sq. ft. or 0.18 acre (approx. 1/6th acre.) All mound evaluations were accomplished using the minimal disturbance technique.

Pre-counts were taken on 11 June 1999. Active mound numbers were arrayed from highest to lowest and divided into four equal groups (replications). Treatments were then assigned within replications so that the total number of active mounds (sum of four replications) was as equal as possible for each treatment. **Table 1** summarizes the treatments used in this test.

Table 1. Treatments applied.

Treatment	Rate (/acre)	Application
1) untreated	-	-
2) Amdro® (0.73% hydramethylnon)	1.5 lb	full coverage
3) Clinch™ (0.011% abamectin)	1.0 lb	full coverage
4) Distance® (0.5% pyriproxyfen)	1.5 lb	full coverage
5) Extinguish™ (0.5% s-methoprene)	1.5 lb	full coverage
6) Logic® (1.0% fenoxycarb)	1.5 lb	full coverage
7) Amdro + Clinch	0.75 + 0.75 lb.	full coverage
8) Amdro + Distance	0.75 + 0.75 lb.	full coverage
9) Amdro + Extinguish	0.75 + 0.75 lb.	full coverage
10) Amdro + Logic	0.75 + 0.75 lb.	full coverage
11) Amdro Skip Swath	1.5 lb. (0.75 actual)	30' skip swath
12) Clinch Skip Swath	1.5 lb. (0.75 actual)	30' skip swath
13) Clinch Reduced Skip	1.0 lb. (0.5 actual)	30' skip swath
14) Distance Skip Swath	1.5 lb. (0.75 actual)	30' skip swath
15) Extinguish Skip Swath	1.5 lb. (0.75 actual)	30' skip swath
16) Logic Skip Swath	1.5 lb. (0.75 actual)	30' skip swath
17) "2-bait" method	-	-
a) Amdro	1.5 lb.	full coverage
b) IGR (Extinguish)	1.5 lb.	full coverage as needed later

Two vehicles were used to apply the baits so that treatments could be accomplished within one 24-hour period on this very large test. A Herd Model GT-77 seeder on a John Deere 'Gator 4x6 utility vehicle was used to apply the hopper blend and "2-bait" treatments. Because the speed of this vehicle could not be set to a high degree of accuracy, the total amount of bait needed for each plot was placed in the hopper and applied to the plot until used. All plots were fully covered with any remaining bait scattered in an even manner across the plot.

A Ford 3000 tractor with a Herd GT-77 seeder was used for the full-rate, full-coverage and skip-swath treatments. The flow rate of the different baits varied and accurate skip-swath application depends on accurate calibration. Therefore, all four plots of the full-rate, full-coverage treatment of one bait were applied first. The appropriate amount of bait was weighed out and applied until it was used. Gate opening adjustments were made during application so that calibration was as accurate as possible and there was no re-coverage needed to use up the material. Then, without changing any application parameters (gate opening, speed, spreader height, etc.), all four skip-swath applications of the same bait were made to the appropriate plots.

The proper amount of bait was weighed out, plus some extra to ensure consistent flow, and placed in the hopper before treating each plot. This step was not completely necessary given the calibration, but it was done to detect any problems such as the gate vibrating closed, blocked flow or other occurrences that might affect an accurate application. Any remaining bait (of which there was usually very little) was carried over to the next plot, but no re-coverage was made. This procedure was then repeated for the next bait, making any necessary calibration changes. Skip swaths were applied perpendicular to the pavement, across the width of the plots, so that the sampling swath would cross as many skips as possible (five) to better test the application technique.

The first treatment (full-rate, full-coverage Extinguish) was applied at dark on the evening of 14 June 1999. Because of heavy dew, applications were delayed until about 10:00 a.m. the morning of 15 June. Application of the hopper blends and the Amdro application of the "2-bait" treatment were completed by about 2:30 p.m. Treatments using the tractor were applied as described above in the following order: Extinguish skip-swath, Amdro (full then skip-swath), Distance (full, skip), Clinch (full, skip) and Logic (full, skip). Each set of four plots took about an hour to complete. The final plot of the Logic skip-swath treatment was completed at approximately 6:30 p.m.

Weather conditions throughout the day were partly to mostly cloudy, temperature 85 - 92°F with a slight breeze. Soil was moist from rains the previous week and ants were foraging very actively. Thunderstorms were seen in the area beginning in mid-afternoon, despite a rain-free forecast. Treatments could not be delayed because they were in progress and rain *was* forecast for the next several days. At approximately 7:15 p.m. a thunderstorm moved across the airport and appeared to stop and rain itself out. Rain was moderate to heavy until at least dark (about 8:30) when our personnel left. The airport weather monitoring system was just being brought on-line at this time, so no measured rainfall amounts could be obtained. It is estimated, however, that at least one and a half inches, possibly more, were received.

Post-treatment evaluations were conducted on 6 July (3 weeks post-treatment), 3 November 1999 (21 weeks) and 2 March 2000 (37 weeks).

Results

Because of the heavy rain shortly after application, there was considerable concern as to whether at least some of the treatments had been ruined and whether it would be necessary to abandon the test. However, as shown in **Table 2**, results indicate that the full-rate, full-coverage treatments of all the baits yielded a speed and level of colony suppression that was as good or better than what is normally expected for those products.

Table 2. Mean number of active mounds per 0.18 acre plot, four replications.

	Mean number of active mounds			
Treatment	Pre-count	Week 3	Week 21	Week 37
Untreated	26.00 a	19.75 a	27.50 a	20.00 a
Amdro (A)	26.00 a	3.50 bcde	2.50 bc	2.50 b
Clinch (C)	25.75 a	11.00 abcde	4.00 bc	4.50 b
Distance (D)	26.00 a	12.25 abcd	0.25 c	0.25 b
Extinguish (E)	26.00 a	22.00 a	0.50 bc	1.25 b
Logic (L)	26.25 a	18.75 a	0.75 bc	2.50 b
A + C	26.00 a	4.50 bcde	4.00 bc	4.50 b
A + D	26.00 a	1.25 de	3.50 bc	4.25 b
A + E	26.00 a	4.50 bcde	3.75 bc	2.00 b
A + L	25.75 a	1.00 e	2.25 bc	1.50 b
Amdro Skip	26.00 a	12.50 abc	14.50 ab	7.00 b
Clinch Skip	26.25 a	18.00 a	14.00 abc	8.25 ab
Clinch Skip	25.75 a	14.00 ab	11.25 bc	10.25 ab
Distance Skip	26.25 a	22.00 a	4.50 bc	3.00 b
Extinguish Skip	26.00 a	17.00 a	10.25 bc	5.00 b
Logic Skip	26.00 a	16.25 a	3.75 bc	4.00 b
2-bait (Amdro only)	26.00 a	2.75 cde	14.25 abc	4.25 b
F	20.91	12.43	6.09	3.44
Probability	0.0001	0.0001	0.0001	0.0003
R^2	0.8922	0.8311	0.7068	0.5762
Min. sig. diff.	7.9307	11.027	14.221	12.908

Means in the same column followed by different letters are significantly different ($P < 0.05$) using PC SAS analysis of variance procedures. Means separated using Tukey's studentized range test.

Discussion

The first important observation is that the test worked at all. Traditionally, it is advised that there be at least 24 hours without rain after bait application to assure effectiveness. Here, the final Logic skip swath plot was treated less than an hour before a major rain event, with the other three plots applied at about 15 minute intervals before that. Even though conditions were not ideal, the effectiveness of this final treatment lends validity to all the others, despite the rain.

Three weeks post-treatment

At three weeks post-treatment, Amdro and all the hopper blends had significantly ($P<0.05$) fewer active mounds than the untreated control plots and were at least numerically lower than all the slow-acting bait products and the skip swath treatments. These results support the idea that a 50:50 blend of Amdro (or possibly other fast-acting baits) applied at a total of 1.5 lbs./acre plus a slow-acting bait will substantially speed the activity of the slow-acting baits, their main drawback from a practical standpoint.

There were also large numerical differences between the four slow-acting baits at three weeks post-treatment. Both Distance and Clinch, full-rate, full-coverage treatments had substantially fewer active mounds than Logic and Extinguish-treated plots. This, too, is characteristic of these baits. Clinch, abamectin, is not a true IGR, but demonstrates IGR-like activity in that it does not kill a substantial number of adult ants, at least compared to a toxicant such as hydramethylnon. Distance, pyriproxyfen, on the other hand, <u>is</u> an IGR, yet still provides more rapid mound suppression. Several tests in recent years from independent sources have shown this same more-rapid-than-normal activity for pyriproxyfen, but a reason is not known at this time.

Skip swath treatments of Amdro showed less than half the suppression of full-rate, full-coverage Amdro. This treatment was included in the test as a negative control, based on previous tests, so the result was expected. The slow-acting bait skip-swath applications showed minimal suppression at three weeks, again, as expected.

21 weeks post-treatment

By early November, 21 weeks post-treatment, all full-rate, full-coverage treatments appeared to have reached their maximum level of suppression, greater than 85% compared to the untreated control. Distance, in particular, had only a single active mound in four sampling swaths with Extinguish and Logic having only two and three, respectively. The hopper blend treatments maintained good levels of control with fewer than four active mounds per plot, compared to 27.5 for the untreated control, on average.

The skip-swath treatments also began to show mound suppression. Overall, active mound reductions were not quite as great as the full-rate, full-coverage treatments, but were significantly ($P<0.05$) less than the untreated control. Substantial numerical differences appeared between treatments, however, though no statistically significant differences were found. Amdro skip-swath, as mentioned, acted as a negative control and experienced little change in mound numbers. from the previous evaluation. Logic skip-swath, which was included as a positive control for skip-swath, based on past research, performed as expected with > 85% control. Distance skip-swath performed similarly. However, Extinguish and both rates of Clinch skip-swath yielded less than half the control of the other skip-swath treatments and, at most, 62% control versus the untreated plots. It is suspected that Clinch, because of its insecticidal properties, acted more like Amdro than an IGR and was not spread among colonies or ants that were not directly exposed. These results suggested that the relatively unstable active ingredient of Extinguish, s-methoprene, may have lessened its effectiveness as a skip-swath, but later results showed that an already slow treatment may just be even slower when applied as a skip swath.

37 weeks post-treatment

The winter of 1999-2000 was very mild and relatively dry with warm temperatures arriving by late February. There were virtually no changes over four months in any of the full-rate, full-coverage or hopper blend treatments. Untreated control plot active mound numbers declined by about 25%. The only notable changes were in the skip-swath treatments. Surprisingly, the number of active mounds in the Amdro skip-swath plots dropped by half. They also dropped by half in the Extinguish skip-swath plots. There was a numerical decline of about 40% in the Clinch 1.5 lb/ac skip swath plots, as well. With the exception of both Clinch skip-swath treatments, all other treatments were statistically similar and had significantly ($P<0.05$) fewer active mounds than the untreated control plots. Not including the two Clinch skip-swath treatments and the uncharacteristically effective Amdro skip-swath, control rates ranged from Distance full-rate, full-coverage with only a single active mound, to Extinguish skip swath with a greatly-improved 80% control versus untreated control plot numbers.

The continued slow decline of Extinguish skip-swath active mound numbers indicates that it may still be as effective as full-rate, full-coverage treatments, though remarkably slow, when applied in this manner. The decline in Amdro skip-swath plots was surprising, given results of past tests and no plausible explanation can be offered at this time.

This is an ongoing test and only the first trial for several of the treatments, so the results should not be considered definitive without further replication. Also, the question of control duration, a strength of slow-acting baits, remains to be answered over time. However, at present, we feel that firm support can be given to several of the important objectives of the test:

1) All five broadcast baits performed exceptionally well when applied at full rate, full coverage.
2) The slow speed of active mound suppression, characteristic of slow-acting baits, was improved to that of Amdro alone when applied as a 50:50 hopper blend with Amdro.
3) Maximum control with skip-swath applications appears to be similar to full rate, full-coverage treatments for Logic (fenoxycarb), Distance (pyriproxyfen) and, *eventually*, Extinguish (s-methoprene). Though control was not numerically quite as good as when these baits are applied at full-rate, full-coverage, it was disproportionately better considering that half the material and labor were used. Amdro and Clinch appear to have a proportional response.
4) Finally, even a major rain event within a few hours of application did not decrease the effectiveness of these products. Though the 24-hour without rain recommendation is still a good one, users should be reminded that rain within a few hours of bait application does not necessarily mean a wasted treatment.

FIRE ANTS IN CALIFORNIA: THE FIRST FIELD TRIALS

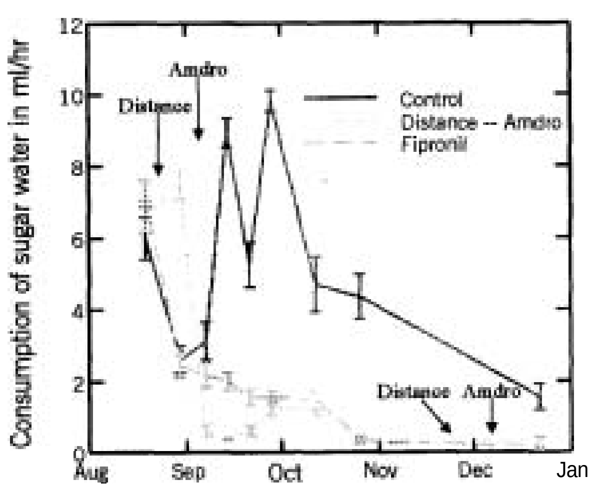
Les Greenberg and Mike Rust, UC Riverside

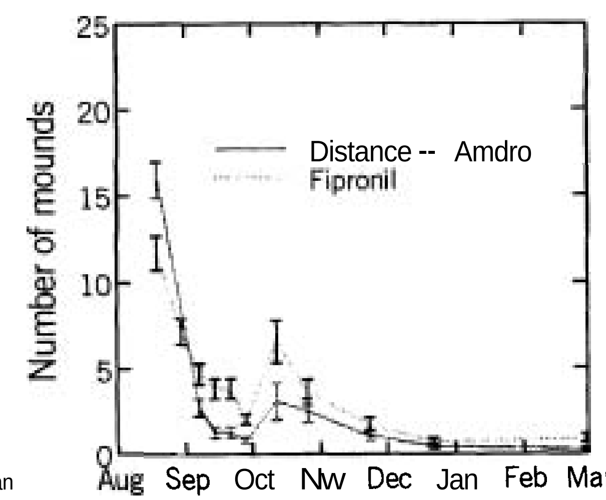
Some of the heaviest fire ant infestations in California are in the Coachella Valley near Palm Springs. Several golf course communities are heavily infested. Golf courses are a challenging environment for fire ant control because the most widely used baits deteriorate rapidly in the presence of water. Given the value of their turf, most golf courses are reluctant to turn off the sprinklers for more than one day. We were therefore interested in trying a fipronil granular product that can be applied without turning off the water.

We used a drop-spreader to apply the granular fipronil adjacent to the houses alongside 3 holes of the golf course. There were 24 houses in all. The rest of the course was treated by the management with an initial treatment of pyriproxyfen followed about 1 week later with Amdro. We were therefore able to compare our results with their treatment. A control area consisted of a hillside adjacent to another nearby golf course that was not being treated at that time.

Mounds can be hard to find in these areas due to frequent mowing. We therefore used consumption of 25% sugar water as an indicator of ant density. Sugar water was placed in graduated plastic vials that were placed every 20 ft around the houses. The vials are slightly inclined by placing them on a plaster holder. After 24 hrs the volume consumed could be read directly by holding the vial vertical and reading the scale, approximating to 0.1 ml. Evaporation from these vials is usually 0.1 ml or less. Where possible we also made mound counts and recorded the information at the same time as the consumption data. Mound counts could not be made in the control area.

The results show that ant activity decreased very quickly after the Amdro treatments The fipronil was slower, but after 5 weeks there was no statistical difference between the Distance – Amdro treatments and the fipronil treatments. Control with both treatments was still very good after 27 weeks. However, the spring will tell whether the ant populations recover. We are particularly interested in seeing whether the fipronil has long-term residual effects in this heavily-watered environment.





PRELIMINARY RESULTS OF INTRANIDAL INSECTICIDAL BAIT TREATMENTS ON THE RED IMPORTED FIRE ANT, *SOLENOPSIS INVICTA* (HYMENOPTERA: FORMICIDAE)

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ABSTRACT

An "island" population of the red imported fire ant was discovered in the summer of 1998 at Chamizal National Memorial in El Paso, Texas. We are trying to eliminate *Solenopsis invicta* but at the same time protect the native ant populations in the Memorial. The insecticides AMDRO®, Logic®, Extinguish™, and combinations of AMDRO®/Logic®, and AMDRO®/Extinguish™, were evaluated with baits placed in the fire ant nests. The insecticides were placed in two 45-mL centrifuge tubes with ten holes (2-mm diameter) to allow access for fire ants in 101 colonies. The effectiveness of the insecticide delivery system was tested in both the field and laboratory. Laboratory tests were effective, but field treatments appear to have had a modest effect on surface activity. Substantial activity within the nests and high labor costs lead us to suggest that current broadcasting and individual mound treatment methods are more appropriate to control island infestations.

INTRODUCTION

The red imported fire ant, *Solenopsis invicta* was discovered at Chamizal National Memorial, in El Paso, Texas during the 1998 Texas State survey. Chamizal National Memorial requested that an additional survey be conducted to determine the extent of infestation. It was determined that *S. invicta* was the second most dominant species present at the Memorial (Moreno et. al, 1999). The Memorial has weekly outdoor concerts in the summer months that regularly attract 5,000 to 9,000 spectators and at the Fourth of July Concert, the crowd increases to 22,000+ spectators.

The rapid expansion of the red imported fire ant observed in urban areas of eastern Texas brought alarm to the Memorial administration. The aggressive behavior of *S. invicta* causes problems in urban environments (Riggs, 1998). Some individuals are hypersensitive to the venom and may suffer chest pains, nausea or lapse into a coma from a single sting, (Drees, 1988).

The objective of this experiment was to evaluate insecticidal baits placed in the nests of *S. invicta*. Intranidal baits were used for two reasons: (1) to protect the diverse biological ant fauna found at the Memorial and (2) to minimize public interference with the bait stations. There are several biological competitors and predators of *S. invicta* found at the Chamizal National Memorial. Moreno et al. (1999) found 15 other ant species present at Chamizal National Memorial. The insecticide delivery system was tested in both the field and laboratory.

MATERIALS AND METHODS

Field Methods (Fall)

Chamizal National Memorial is located in the middle of south central El Paso with roughly 13.76 hectares of mesic habitat. The two zones were sampled in August with surface baits every 10 meters in a rectangular grid 330 meters long and 170 meters wide. This included areas known as the "bowl", where the outdoor stage is located, and the lawns around the administration and visitor's center buildings. The bowl area is oval shaped, approximately 1.62 hectares in area, surrounded by a paved road, with a depression in the center and trees run along the rim of the bowl. The areas around administration building and visitor's center are lined with planters and trees. Walking trails lead up the lawns to both buildings. The zones are either separated by a road or concrete structure. A total of 486 surface baits were used. The paved roads, the administration building, and visitors center were not included. One ounce condiment "Dixie®" cups and lids, each containing one piece of tuna flavored Tender Vittle® cat food were used as surface baits (Moreno et al., 1999.) After laying out the baits for thirty minutes, they were collected, stored in a cooler, and taken to the Fire Ant Laboratory at UTEP for identification.

In early October a meter by meter search for ant mounds was conducted at each of the sites. All mounds identified as *S. invicta* and at least 15 centimeters wide and 7 centimeters high were included in our treatments. All mounds 30 centimeters in diameter were assigned as one treatment site. Mounds less than 30 centimeters in diameter that were within three meters of other mounds were assigned to the same treatment site. The remaining mounds 15 to 30 centimeters in diameter and not within three meters of other mounds were assigned as a treatment site. Mounds less than 15 centimeters wide were excluded. The nests were randomly assigned to the five treatments or a control group.

AMDRO®, Logic®, Extinguish™, and combinations of AMDRO®/Logic®, and AMDRO®/Extinguish™, at dosages recommended for mound treatments were used. The combination treatments were half of the prescribed amounts of each insecticide. Insecticides were placed in two 45-mL centrifuge tubes. The centrifuge tubes had ten 2-mm holes drilled in the upper part of each tube to allow ant access. The centrifuge tubes were buried 30 centimeters deep in the ant mounds. Two labeled tin roofing disks 6.5-cm in diameter were also placed with the centrifuge tubes and covered with dirt in order to assist in locating the nests later. From 17 October to 21 November 1998 we checked for mound movement and mound activity weekly. We sampled for foragers with baits along 6 transects in the treatment sites and 6 outside the treatment sites once a week for six weeks after treatment.

Laboratory Methods (Winter)

The laboratory setup involved 16 small plastic boxes, 18-cm x 12.5-cm x 6-cm coated with Fluon®. One set was labeled 45-mL AMDRO®, another set labeled as Cup AMDRO®, another as 45-mL Control, and the last as Cup Control. Each set contained 4 boxes numbered 1 through 4, an each box contained 200 ants. The 45mL centrifuge tubes were prepared as described above and placed in the eight pre-labeled boxes. The laboratory experiment began on 27 March 1999 and ended on 5 April 1999.

AMDRO® insecticide was selected because it is a metabolic inhibitor, as opposed to the two other treatments used at Chamizal National Memorial, which are growth regulators. The growth regulators interrupt development during the larval stage. The ants selected for the experiments were adults, thus rendering growth regulators useless. The treatment boxes all contained 2.3 grams of AMDRO® in each container. The ants were fed ad libitum and watered daily. The ants diet consisted of ground beef heart, mosquito larva, and agar. The ants were kept in an environmental chamber at 32° C with a 12-hour day light cycle. The boxes were removed from the chamber daily to count and remove dead ants.

Field Methods (Spring)
Approximately six months after intranidal treatment, we located the mounds with the roofing tins using a metal detector, and excavated the nests. We looked at surface activity, the 45mL centrifuge tubes, and the interior mound activity (i.e. brood, reproductives, and soldiers). Surface activity was measured on a 0-4 scale with four indicating high activity and zero indicating ants not present. The contents of the 45-mL centrifuge tubes were labeled as either dry, dry moldy, wet rotten, or empty. Interior activity was labeled using the same scale as surface activity.

Analysis of Data (Fall, Winter, and Spring)
Surface data collected over the six-week period in the fall were averaged for each treatment site. The data were then grouped according to treatment classification. Surface data collected in the spring for each treatment site were grouped with the fall treatment classification. Spring surface activity was subtracted from the fall surface average. This difference in spring/fall surface activity was analyzed using a Wilcoxen-Mann-Whitney statistical test. We used a 95% confidence level when computing our data. The control mean with standard deviation was then compared to each of the treatment means. Data for the Laboratory experiments were computed using a trend analysis program (Minitab) and plotted.

RESULTS

Field Results (Fall and Spring)
Of the 486 surface baits laid out in the rectangular sampling site, 226 cups contained ants. *Solenopsis invicta* was present in 52 of the 226 cups. From the meter by meter search, we located and identified 118 mounds in the bowl area. In the area surrounding the administration building and visitor's center we located 35 mounds. Of the 118 mounds identified in the bowl, 111 were *S. invicta* and all the mounds around the administration building and visitor's center were *S. invicta*. Using the above mound criteria we selected 101 treatment nests from a total of 153 *S. invicta* mounds; the remaining mounds were either too small or grouped together.

Data from the analysis of differences between the fall and spring activities were analyzed, (Fig. 1). Surface activity was reduced from fall to spring in the treated nests (most treatments below zero, Figure 1), when compared to the control nest, which showed an increase (above zero, Fig. 1). The Control nest had a mean difference of 0.539 ± 0.987 standard deviation (SD) in the data points. The Logic® treated nest showed a mean of -0.062 ± 0.511 SD. The AMDRO® had a mean difference of -0.304 ± 0.722 SD, the AMDRO®/Logic® had a mean difference of -0.313 ± 0.701SD, and the AMDRO®/Extinguish™ had a mean difference of 0.230 ± 0.776 SD. The Extinguish™ had a mean difference of 0.047 ± 0.706 SD.

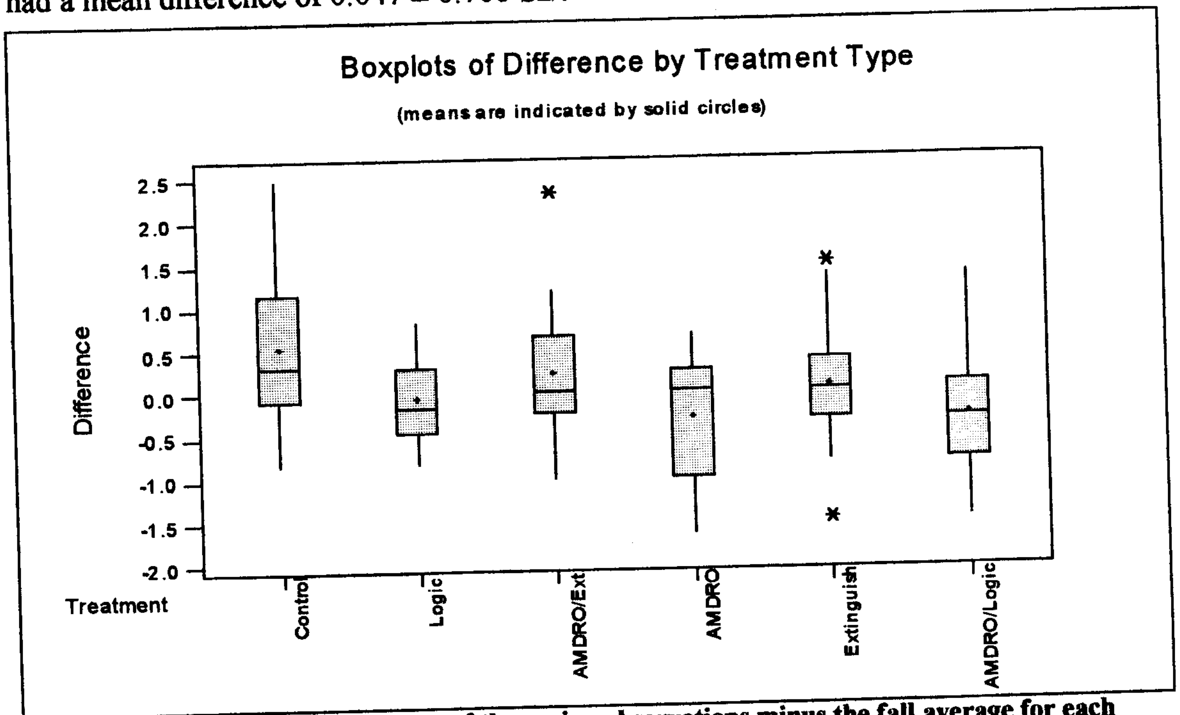

Figure 1. Boxplots of the differences of the spring observations minus the fall average for each of the treatments. The (*) symbolizes possible outliers in the data.

From the Wilcoxen-Mann-Whitney statistical analysis we found that only the activity AMDRO® and AMDRO®/Logic® treated nests were significantly lower than the Control nests. Furthermore the AMDRO® treated group had an average decrease of approximately 0.0 to 1.5. The AMDRO®/Logic® treatment group has an average decrease of 0.17 to 1.33.

Laboratory Results

The averages of the treatments were plotted and shown as the remaining live ants over time. The y-axis is the number of live ants remaining while the x-axis represents the number of days the experiment was conducted, (Fig. 2).

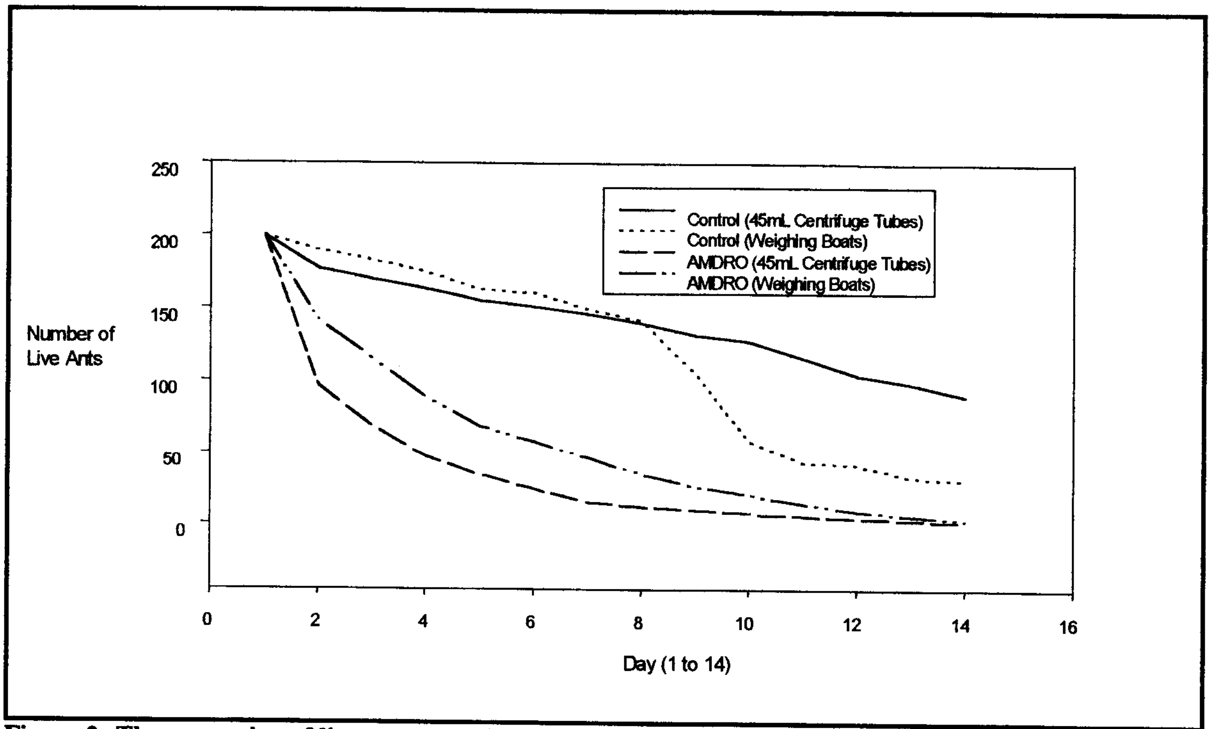

Figure 2: The regression of live ants over time. The treatment groups decrease exponentially.

DISCUSSION

There was an observable difference in mortality rate between AMDRO® treated ant groups and the control ant groups in the laboratory experiment. We noted a greater decline of ants from the 45-mL centrifuge tube treatment groups even though the open weighing boats offered more access to AMDRO®. The ants also found the bait much quicker than ants with open containers (usually within five minutes.) Sharing of bait was observed within ten minutes of introduction. Our results show that the 45-mL centrifuge tube is an ideal method of insecticide dispersal in a laboratory environment.

AMDRO® and AMDRO®/Logic® treatments appear to have reduced the activity of *S. invicta* in the bowl area and around the administration building and the visitor's center. An AMDRO® treated nest only contained majors and reproductives, suggesting the nest experienced a decline due to AMDRO® (J. Cook, pers. comm.). The excavation of the ant nests; however, revealed nest activities, with an abundance of workers and soldiers. On most occasions, we discovered several brood chambers and reproductives. The contents of the 45-mL centrifuge tubes contained varying degrees of degradation due to water infiltration. The majority of the tubes received a wet rotten rating. The labor intensive application of the intranidal baits proved to be quite discouraging when considering that broadcasting the same area would only take a fraction of the time used to lay the baits with our method. Of the seven non *S. invicta* mounds discovered in the bowl area, only two remained and both had well maintained mounds. We do not consider this a reliable and cost effective method to treat *S. invicta* in an island population such as that found at the Memorial, for the above reasons.

ACKNOWLEDGEMENTS

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EFFICACY OF BROADCAST AND PERIMETER APPLICATIONS OF S-METHOPRENE FOR CONTROL OF THE RED IMPORTED FIRE ANT

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Introduction

Since the introduction of the red imported fire ant (RIFA) ***Solenopsis invicta*** Buren into Mobile, AL, in the 1930s, this ant has become a widespread pest in pastures throughout the southeastern United States. Research has focused on management plans that employ strategic use of insecticides to reduce treatment costs for landowners. The insect growth regulator methoprene (Extinguish®) was selected for this study because it is registered for fire ant control in grazed pastures.

Research Objectives

- To evaluate the efficacy of broadcast applications of Extinguish® at 1 lb/acre for control of the red imported fire ant.
- To evaluate the spread of S-methoprene in plots receiving perimeter applications of Extinguish® at ¼ lb/acre.
- To assess the practicality of methoprene applications for the control of fire ants in grazed pastures.

Materials and Methods

Design: Grazed pastures located ten miles north of Auburn were selected for this study. Nine 1-acre plots were set up in a random complete block design, with each block containing one perimeter and one broadcast application and an untreated control (Zar 1999). Plots were separated by a 30-m buffer zone to ensure treatment independence.

Treatment: Applications of Extinguish® were made with a Toro® prototype bait spreader that provided a 10-foot treatment swath. Twenty swaths were run throughout the broadcast plots delivering 1 lb/acre. One swath was run along the border within the perimeter plots delivering ¼ lb/acre.

Mapping: Mounds were mapped, counted, and rated before treatment, then again at 8 and 16 weeks after treatment. A backpack Global Positioning Systems (GPS) unit consisting of a 7000 C-Band GPS receiver, a Hewlett Packard HP200 palmtop computer, and a 12-V battery, was used for mapping. Aerial photographs were acquired from Microsoft Terraserver (http://terraserver.microsoft.com)and georeferenced using Image Analysis software in ArcView® 3.1 Geographic Information Systems (GIS). All field data were entered into ArcView® GIS for analysis and presentation. Mounds were rated by size and brood production using the USDA-APHIS Population Index (Table 1) (Callcott and Collins 1992).

Statistical Analysis: Mound counts and population indices were analyzed with Analysis of Variance (ANOVA) using two-way repeated-measure General Linear Models in SAS. Pre-treatment measures were contrasted with two post-treatment measures. Mound counts and indices were dependent variables, with treatments and block effects as factors. A Fisher's Least-Significant-Difference (LSD) test was used to locate significant treatment results.

Table 1. USDA-APHIS Population Index (PI) with categorical values for measuring fire ant mounds. N equals the number of mounds; K equals assigned weight based on size and reproduction.

$$PI = \sum^{25}_{K=1} K\,(N_K)$$

Number of Ants/Mound	Weight (K) Brood Absent	Brood Present
< 100	1	5
100 – 1000	2	10
1000 – 10000	3	15
10000 – 50000	4	20
50000 <	5	25

Results

Mound Counts: The mean number of mounds in the broadcast plots decreased by 31% at 8 post-treatment and 85% at 16 weeks post-treatment (Tables. 2 & 4; Fig. 1; Maps 1& 2). Analysis of mound counts with ANOVA determined that mound reductions at 8 weeks post-treatment were not significant ($F_{4,8}=1.16$; $P=0.403$), but mound reductions at 16 weeks post-treatment were significantly different from controls ($F_{4,8}=13.59$; $P=0.0165$) (Tables. 4 &5; Fig. 1; Maps 1 & 2).

The mean number of mounds in the perimeter plots decreased by 9% at 8 weeks post-treatment and 23% at 16 weeks post-treatment (Tables 4 & 5; Fig. 1). Mound reductions in perimeter plots were not significantly different from untreated controls (Tables 3 & 4; Fig. 1; Maps 1 & 2).

Table 2. Number of RIFA mounds through time for broadcast plots.

Block Number	Pre-treatment	8 weeks	16 weeks
1	36	17	9
2	36	21	1
3	24	24	4

Table 3. Number of RIFA mounds through time for perimeter plots.

Block Number	Pre-treatment	8 weeks	16 weeks
1	13	17	12
2	36	21	24
3	23	19	18

Table 4. Mean number of RIFA mounds per treatment plot with standard error (SE).

	Pre-treatment	8 weeks	16 weeks
Broadcast	32 (4.294)	22 (3.052)	4.67 (3.132)
Perimeter	23.33 (4.294)	21.33 (3.052)	18 (3.132)
Control	29.67 (4.294)	27.33 (3.052)	27.67 (3.132)

Table 5. ANOVA results for pre-treatment and post-treatment mound counts.

Time	F	Pr>F
Pre-treatment	1.09	0.4188
8 weeks	1.16	0.403
16 weeks	13.59	0.0165

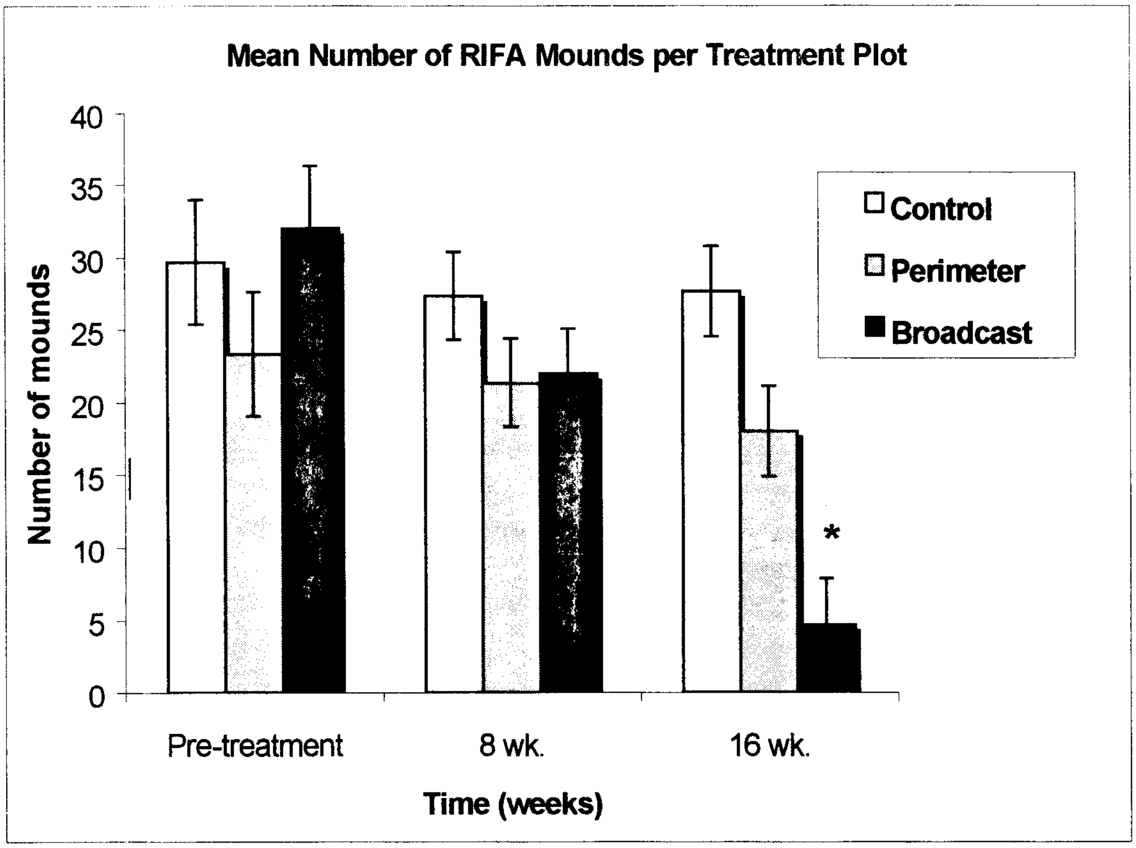

Figure 1. Mean number of RIFA mounds per treatment plot. Asterisk denotes significant value.

Population Indices: The mean population index in the broadcast plots decreased by 69% at 8 weeks post-treatment and 95% at16 weeks post-treatment (Table 6; Maps 1 & 2). Analysis of population indices with ANOVA determined that reductions at 8 weeks post-treatment were not significant ($F_{4,8}$= 6.18; P=0.0597), but mound reductions at 16 weeks post-treatment were significantly different from controls ($F_{4,8}$=33.02; P=0.0033) (Table 7).

The mean population index within the perimeter plots decreased by 50% at 8 weeks post-treatment. At 16 weeks post-treatment, the mean population index increased to 36% reduction. The mean indices within perimeter plots were not significantly different from controls (Tables 6 & 7; Maps 1 & 2).

Table 6. Mean population index per treatment plot through time.

Treatment	Pre-treatment	8 weeks	16 weeks
Broadcast	708	222	33
Perimeter	474	237	302.66
Control	632.66	549	597.33

Table 7. ANOVA results of pre-treatment and post-treatment measurements.

Time	F	Pr>F
Pre-treatment	1.38	0.3497
8 weeks	6.18	0.0597
16 weeks	33.02	0.0033

Discussion

Although the mean number of mounds decreased in all plots throughout the field season, analysis of mound counts and population indices consistently showed significant treatment effects in the broadcast plots by 16 weeks. Significant declines in population indices were detected at 8 weeks and 16 weeks in broadcast and perimeter plots. As dry conditions persisted, fire ants buried brood deep within the mound thus confounding accurate mound rating.

There are three possible reasons why perimeter bait applications were not successful in this study. First, treatment swaths along the perimeter were over 180 feet apart. Second, fire ants foraging from colonies outside the plot may have removed active ingredient, and thus decreased measurable treatment effects. Third, as mounds inside treatment plots died, pre-existing mounds initially outside of the treatment area relocated within the plots, thus masking the full effect of the treatments.

Conclusions

1) Broadcast applications of Extinguish® at 1 lb./acre significantly reduced fire ant infestations, but detectable treatment effects were not apparent until more than two months after treatment.
2) Perimeter applications of Extinguish® at ¼ lb./acre did not significantly reduce fire ant infestations.

3) Perimeter applications may be applicable on a smaller scale, but may not be practical for pasture settings. Future trials using smaller plots, wider swaths, and more active ingredient should be conducted to determine the spatial effectiveness of this approach.

Acknowledgements

John Beck, Phil Chaney, Kathy Flanders, David Gaylor, Fudd Graham, Mark MacKenzie, Joe Robertson, and Mark West for their assistance with this project.

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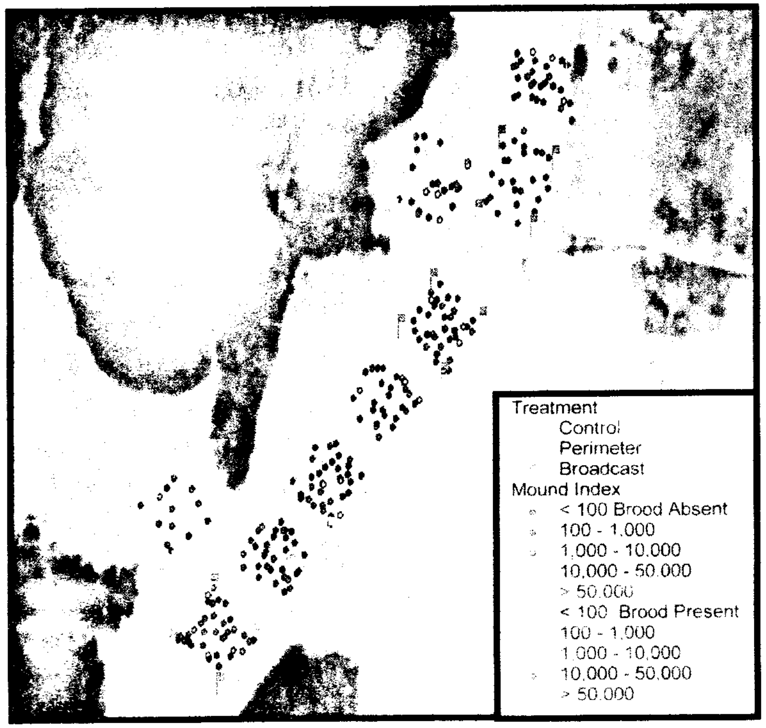
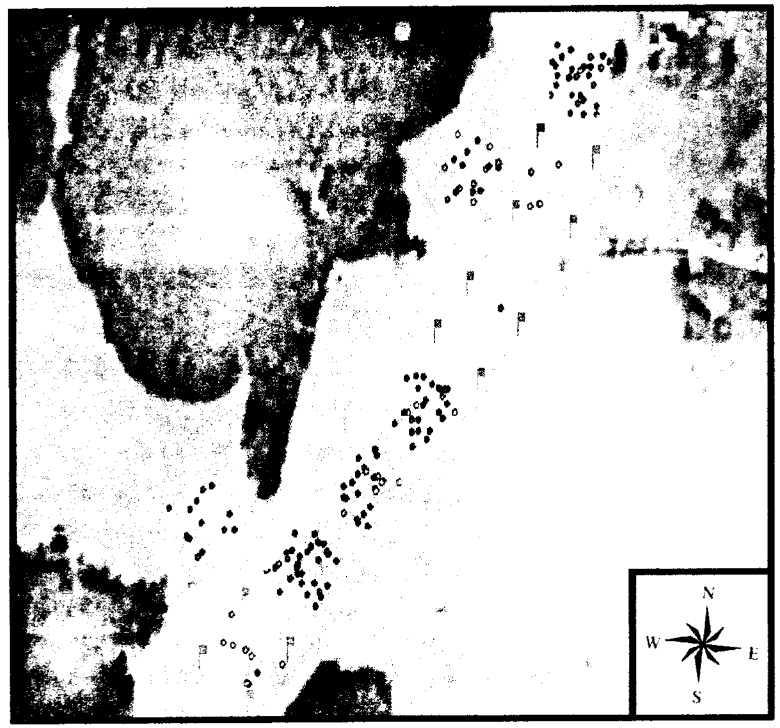
Broadcast and perimeter applications of methoprene in a grazed pasture in Chambers County, AL, 1999



Map 1. Preliminary fire ant activity.



Map 2. Fire ant activity 16 weeks after treatment.

Treatment maps show aerial image of grazed pasture site in Chambers County., AL, with RIFA activity at pre-treatment and 16 weeks post-treatment. Significant reductions in mound activity in broadcast plots are evident 16-weeks post treatment.

PROTECTING YOUNG CITRUS FROM RIFA DAMAGE

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The red imported fire ant has been identified as an important pest in the citrus groves in Florida and Texas. These insects can directly injure the young trees by girdling, but also by feeding on the young growth shoots and flower buds. Indirectly the ants are detrimental because they also protect a number of homopteran insects, such as scales, aphids, and mealy bugs and these insects are capable vectoring various diseases in citrus.

The cooperative Extension Service in Florida began receiving complaints in the early 1980's of young citrus trees being killed by RIFA. Ants nesting near the base of young citrus trees, crawl up within tree wraps and were observed feeding on the bark and cambium to obtain sap, often girdling and killing individual trees (Knapp & Wojcik, 1992). Wounds in the bark created by fire ant feeding allowed entry of pathogenic fungi, causing die-off of trees described as "foot rot" in the industry. RIFA also feed on young shoot growth and the flowers of developing fruit, weakening or killing trees and delaying production of fruit (Smittle et al 1988, Banks et al 1991). In newly planted groves in Volusia and Indian River Counties in 1984, almost 40 percent of the trees had RIFA damage, with up to 17 percent mortality (C.T. Adam1986). Replacement costs of young trees in groves infested with RIFA were three times that of non-infested groves, ranging from $300 to $1000 per hectare depending on hybrid and rootstock used. Normally grove managers plan approximately 300 young orange tree per hectare.

Replacement of dead and diseased trees in citrus groves is an important part of the total production program. With overhead and production costs escalating, tree replacement to maintain a full stand of trees is an important part of management. Diseases, insect problems and freezes have been particularly troublesome to the Florida growers in the past two decades. Extensive tree losses coupled with the economic necessity of regular resetting have caused many growers to investigate ways to achieve new efficiencies in reset management (L. K. Jackson, 1994). Caring for your citrus is challenging because these young trees require more attention in the form of water, protection, fertilization, weed control and pest management than larger more established trees. Resets pose an even greater problem since they are scattered throughout a block of larger trees, making them difficult to locate and easily overlooked. For this reason, researchers and growers have been exploring new methods and labor and energy saving techniques for providing young tree care. This is a report on one such device that excludes RIFA from young citrus trees in the field. This study was carried out in five separate groves throughout florida included over one thousand trees and records were kept on the efficiency of this device to exclude crawling arthropods on young citrus for two seasons or 18 months.

METHODS & MATERIALS

A small device which consisted of a permethrin-impregnated polyvinyl collars with a flared skirt, "TreeGuard," were placed around the base of young citrus trees approximately one to three inches above the ground level to determine if the device would prevent fire ants and other crawling arthropods from crawling up inside the tree wraps and inflicting damage on the young trees. Wraps are a popular method for providing protection from cold, mechanical and chemical (herbicides) injury, as well as eliminating the need for sprout removal. Slow-release insecticide packets (diazinon) have been effective on a short term basis in managing a variety of pests that use the wraps as a harborage. Wraps often stay in place up to three or five years and is usually not removed until the tree is well established and beginning to bear fruit. However, checking the wraps periodically for the presence of certain insects and fungus diseases, such as scab, melanose and sooty molds, is still a very important part of management for young trees. Because of the downturn in the US citrus industry over the past several years, many grower have eliminated the use of expensive insulated wraps and switched to less costly corrugated plastic wraps or aluminum foil wraps beth of which offer no insect protection for the young citrus trees.

This study was conducted at five sites in Florida. Originally the study was to be carried out in the three major citrus growing area of Florida; the east and west coast and the central ridge area. However, outbreaks of the Mediterranean fruit flies and resulting aerial spraying with malathion caused us to drop the plots on the west coast prior to putting on the "TreeGuards." Therefore, four plots were set up in the ridge area of central Florida in various commercial groves and one site in the lower east coast. Every two to four weeks approximately 250 young citrus trees out of approximately 1,000 trees used in this study were evaluated. The tree wrap was removed and the presence of such arthropod pests, such as RIFA, other ants, cockroaches, beetles, weevils, spiders, etc. were noted and recorded. A standard corrugated wrap was used on all test trees at all sites.

An equal number of young citrus trees were evaluated with and without the "TreeGuards." The impregnated polyvinyl collars were placed tightly around the trunk or stem of the young citrus tree at one to three inches about the soil level and held in place by either rivets or velcro. A commercial-grade citrus wrap made of corrugated plastic was placed on the tree over the "TreeGuard" and secured with a twisted wire. These trunk or stem wraps are used routinely in citrus culture to protect the young trees from cold, mechanical or chemical (herbicide) injury. The drawback is that these same wraps also act as roadways or harborage for various arthropods that can and do cause considerable damage or even kill young citrus trees. Arthropods within the wraps attract other predators, such as lizards, spiders, toads, frogs and snakes, which in turn attract larger predators, such as racoons and cranes, that tear off wraps, thus exposing the young trees to cold and possible injury from chemicals and machinery. Snakes, including poisonous varieties, as well as poisonous spiders living with the wraps, can also pose a serious health hazard to citrus grove workers.

The Reese warp, a commercial wrap with a packet of the pesticide diazinon within it, was also evaluated in order to compare the efficiency and cost factor. Counts of active fire ant colonies were made in one grove where the pesticide Lorsban (chlorpyrifos) was put into the irrigation system so that we could measure the efficiency of the Lorsban treatment to control RIFA.

The most common arthropods present in the five sites on a consistent basis were the red imported fire ant (RIFA) *Solonopsis invicta* Buren; the asian cockroach *Blatella asahinai*

Mizukubo and black, brown and red widow spiders, Larodectus. Various other species of ants, cockroaches, earwigs, crickets, weevils, beetles and spiders were present on the trees under the wraps, but they appeared on a seasonal basis and were never in large numbers or found at all the study sites. In all sites at least 15 percent of the trees had moderate to heavy RIFA infestations prior to treatments. (light infestation is observing 5 or less RIFA moving up a ca one foot distant on the stem in 60 seconds or one minute A moderate is 5 to 50 the same distance in one minute. A heavy infestation is 50 plus ants observed in one minute).

In one grove, fifty trees were banded with the "TreeGuard" and no plastic corrugated wrap was put over them to determine if sunlight would break down the product more quickly than if it was protected from the direct sunlight. Periodically a sample of the "TreeGuards" were removed from the tree and evaluated for efficacy using a simple bio-assay in the laboratory. Laboratory colony ants were allowed to crawl on the old "TreeGuard" then observed for mortality at five minute intervals.

RESULTS

The results of this 18 month study were very successful. The "TreeGuards" completely controlled the RIFA for over two seasons on young citrus trees. With or without exposure to direct sunlight, the device served a protective barrier, interrupting the route of travel and eliminating the invasion of RIFA onto the young citrus tree. The tree guard also eliminated other species of ants especially the Florida carpenter ant which was found under the wraps of untreated trees, but never in trees which had the "TreeGuard". In many cases there would be large established RIFA colonies at the base of the trees, but if the device remained in place, no ants were ever found in the tree or under the wrap and usually within a few weeks the colony would move. When the study began, as many as 70 percent of the young citrus in one of the study groves had infestations of fire ants under the protective wraps. However, on an average approximately 18 percent of the young trees in the five groves had RIFA in or on them. Of these about 10 to 20 percent had heavy infestations of RIFA that were causing some economic damage. Based upon these observation it can be assumed that approximately five percent of all young citrus trees are being adversely affected RIFA in Florida.

Most grove managers use Lorsban injected into the irrigation system to control fire ants, if they are bad in the field and adversely affecting citrus production. However, in the one grove where fire ant mounds were monitored for six months during the spring and summer of 1998, there was no reduction in the number active mounds, because of the Lorsban treatments, compared to the number of active fire ant mounds in the same grove where Lorsban was not being used. After the Lorsban treatments there would be a drip in the number forging ants on the tree. It was also noted that Reese wraps with the diazion packet also gave complete control RIFA for the duration of this study.

SUMMARY

The "TreeGuard" gave complete control RIFA in young reset citrus trees for 18 months in the field. This device also excluded most small crawling pests from young citrus tree.

PROTECTION OF NECTAR FEEDERS FOR HUMMINGBIRDS AND BUTTERFLIES AS WELL AS BIOLOGICAL CONTROL RELEASE STATIONS FROM RIFA AND OTHER ANT SPECIES

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Any area of the country that has ants that feed on sugar water, these same ants will find their way to nectar feeders or to biological control release stations if the ants feed on other insects for protein. This phenomena prevents many people from having these feeders or release stations on their property. A small bell shaped device with a permethrin-impregnated polyvinyl disc inside was used and this device is called an "AntGuard to be used on these feeders and release stations.

RESULTS:

Although it took almost five years to come up with the correct design. It always gave excellent exclusion of ants from the feeders and release stations. All field studies were very successful. It is now a commercial product and in the two and half years it has been sold on the open market there has not been one "AntGuard returned.

Fipronil - T. Davis

QUARANTINE TREATMENTS FOR NURSERY STOCK: A RESEARCH UPDATE

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The primary mission of the USDA, APHIS, PPQ, Gulfport Plant Protection Station is to develop quarantine treatments to support the Federal Imported Fire Ant Quarantine Program. The quarantine program regulates the movement of certain items, mainly nursery stock, outside of the quarantined area. Nursery stock which is regulated includes containerized nursery stock, field grown or balled-and-burlapped nursery stock and grass sod. This report will briefly touch on a few current research successes and failures, as well as potential quarantine treatments for nursery stock.

Containerized Nursery Stock:

Fipronil: **Fipronil** granular insecticide, produced by Aventis **CropScience (Rhone-Poulenc** Ag. Co.), was submitted to EPA for registration in 1999. Several labels for use against imported fire ants were included in the registration packet. Registration is expected later this year. Quarantine uses that will be supported by this laboratory include a pre-plant incorporated treatment for containerized nursery stock and a grass sod treatment. Please note that quarantine uses will not be simultaneous with EPA registration. Quarantine approval will have to go through APHIS channels after EPA registration is complete.

SpinOut®: Spin Out root growth regulator technology was developed by Griffin Corporation to enhance the development of dense, compact root growth. The active ingredient is copper hydroxide contained in a latex matrix which is sprayed onto the interior of plastic nursery pots. In a preliminary trial in 1995, Spin Out treated pots (Griffin Corp. working with Lerio Corp.) that also contained various concentrations of bifenthrin (0.25, 0.5, and 1.0% AI) and tefluthrin prevented fire ant colonies from invading the test pots for 24 months. A second trial initiated in 1997 at 5 nurseries in the Southeast used Spin Out 300 combined with various concentrations of bifenthrin (0.25, 0.5 and 1.0% AI). The Spin Out 300 was applied to 1 and 3 gallon nursery pots, however the rate of application of bulk material was 3X less than in the original 1995 trial (this was the result of Griffin perfecting the Spin Out product to deal with economic concerns). Therefore 3X less bifenthrin was available in each pot as an insecticide. Results were less than acceptable in the 1997 trial, and we decided to initiate another trial in 1998 using higher rates of bifenthrin (1.5 and 2.0% AI) combined with the Spin Out 300 to accommodate the lower amount of material applied to the pots. The 1.5% and 2.0% rates of bifenthrin applied in Spin Out to the entire inside of 1 and 3 gallon nursery pots have successfully prevented infestation of nursery pots for 15 months after a 1 to 3 month exposure period. This trial, thus far, supports our original data. This treatment, if granted approval for use in the Federal Imported Fire Ant Quarantine would give nurserymen the advantage of the Spin Out technology for better root growth and control, as well as, protection against transporting IFA in their containerized nursery stock. We will recommend that another trial duplicating this data be initiated in the spring of 2000 to provide confidence in this treatment for quarantine purposes.

***Permethrin/Deltamethrin Impregnated Nursery Pots*:** Brandywine Compounding, Chadds Ford, PA, supplied us with one pint (4.75" x 4.75") nursery containers impregnated with permethrin in 1997. Promising results prompted us to initiate a larger trial to better evaluate the efficacy of the permethrin impregnated pots. In 1999, a large trial with numerous cooperators was initiated; coordinated by Brandywine Compounding and Nursery Suppliers, Inc. Three sizes of nursery containers (1, 3, and 10 gallon) were impregnated with permethrin or deltamethrin. Concentrations of permethrin in the plastic were 0.25, 0.50, 0.75 and 1.0%, and of deltamethrin were 0.025, 0.050, 0.075 and 0.10%. Containers were potted up at various nurseries in the southeast. The nursery that we received pots from for testing was Windmill Nursery. Other trials, not reported here, were initiated in other nurseries and bioassays performed by other laboratories. Six months into the trial, the highest rates of permethrin and deltamethrin have prevented IFA infestation of nursery containers.

Permethrin Impregnated Plastic Sheeting: Many nurseries use plastic or cloth sheeting under containerized nursery stock in the canyard as a weed barrier. Brandywine Compounding has produced a permethrin impregnated plastic sheet for testing as a barrier against IFA. We will initiate testing with this product this spring.

Field Grown Nursery Stock:

Tennessee Flight Trap Study: Tennessee has a large field grown nursery industry and current treatment options for certification of this type of stock are not practical or cost-efficient. Our original premise was that if the last fall mating flights in Tennessee occurred at such time that a bait could be applied approximately 30 days later (when the first mimums from the newly mated queens appear to forage), field grown nursery stock could be certified to move out of the quarantined area without further treatment prior to spring mating flights. However, from the data collected in this trial, it appears that IFA alates are flying and thus capable of mating as late as the first week in December. This would push back the bait application until late December or early January. IFA forage when soil temperatures at 2 cm are 59 to 109°F (15-43°C), with optimum foraging occurring when temperatures are between 71 and 96°F (22-36°C) (Porter and Tschinkel 1987), supporting the general guideline that bait applications should be made when air temperatures are at or above 65°F. Therefore, with mating flights occurring so late in the year in Tennessee, the possibility of a day in late December or early January having temperatures conducive to bait application would be remote. Even if bait applications could be made with confidence of efficacy, the length of time between the last mating flights of the year and control of the subsequent small incipient colonies, which could be as late as the end of January, would probably be unacceptable to the nurserymen. In general, field grown nursery stock is harvested and sold from December through March or April in Tennessee.

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IMPACTS OF A NON-NATIVE ANT, *SOLENOPSIS INVICTA*, ON A KEYSTONE VERTEBRATE, AND ASSOCIATED COMMENSAL FAUNA

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The gopher tortoise, ***Gopherus polyphemus***, is a fossorial species native to the southeastern United States. Tortoise numbers are decreasing throughout their range and red imported fire ants (Solenopsis invicta) may be contributing to this decline. In some habitats, as many as 50% of burrow aprons have S. invicta mounds present placing emerging hatchlings in close proximity to foraging S. invicta. This study experimentally manipulates fire ant densities to determine the potential impacts of fire ants on hatchling survival. Approximately 12 weeks prior to hatchling emergence, half of the study sites (n=10) were treated with LOGIC 7 to reduce fire ant densities. S. invicta densities were significantly ($P<.05$) reduced at all treated sites. After hatchling emergence, hatchlings (n=20) had radiotransrnitters attached and were tracked daily until mortality. All hatchlings were killed by predators before reaching one year of age. Of these mortalities, 25 % (n=5) were killed by S. invicta. In all cases of *S.* invicta induced mortality, the hatchlings were either in untreated areas or had dispersed out of treated areas. These data indicate that *S.* invicta are significant predators on tortoise hatchlings.

A GIS REPRESENTATION OF POTENTIAL RED IMPORTED FIRE ANT RANGE EXPANSION ACROSS THE UNITED STATES

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ABSTRACT

The future range of the red imported fire ant, ***Solenopsis invzcta*** **Buren, (RIFA)** within the United States was predicted based on its current distribution. A dynamic model of colony growth with two time steps per day was formulated to evaluate colony area and alate production. Colony growth rate depends on daily max/min soil temperatures. Temperature records from 4,537 meteorological stations within the current (near 1.5 million km^2) and potential range of RIFA were obtained from NOAA data banks. At each station, a colony was allowed to grow and lifetime female alate production was calculated. Alate production was then matched to the current distribution extremes in Arkansas, Tennessee and Oklahoma. Four zones of colony proliferation success were defined: certain, possible, undemonstrated, and improbable. An annual precipitation limit was selected to indicate regions where arid conditions may prohibit growth in non-irrigated areas. Results of the model predict that RIFA will likely move 80 to150 km north in Oklahoma and Arkansas. They will also likely continue expanding into portions of Virginia, Maryland and Delaware in the east, and New Mexico, Arizona, California, Oregon, Nevada and maybe even Washington in the west. Geographic Information Systems (GIS) software tools were used to visualize and spatially analyze the results of this model.

INTRODUCTION

There are two major reasons to model RIFA range limits. First, *S. invicta* is an important economic pest (Thompson et al. 1995) and knowledge of its potential range limits will indicate where quarantine efforts are most needed. Secondly, its biology and ecology are comparatively well known (Wojcik and Porter 1997) making the effort interesting and tractable from a scientific standpoint. Imported fire ants are currently distributed across much of the southern United States where they occur in habitats with a wide range of temperature and precipitation.

Since soil temperature is the main ecological factor determining colony metabolism and activity (Tschinkel 1993, and many others), it was used as the primary ecological factor in model development. The current model is an elaboration of the original (Korzukhin and Porter 1994, Thompson et al. 1999) and defines four zones of potential range expansion.

Several assumptions were made to simplify the modeling approach. Colonies were described by two dynamic variables: a) colony area and b) daily alate production. Increases and decreases in colony area were governed by soil temperature. The model was calibrated to adjust the calculated range to the furthermost points in the present distribution, so the total number of alates produced by a colony was considered a free parameter.

MODEL CONSTRUCTION

The model assumes that the number of workers in a colony is proportional to the area of its territory. Consequently, the size of a colony is given by colony area. From this, colony alate production can be calculated. Availability of two temperature values for each day, allows the use of two time steps per day.

Colony Area Dynamics. Within the model, two opposite processes (production and death of workers) determine the dynamics of colony area. These rates depend on soil temperature and were determined from laboratory observations (Porter 1988, Calabi and Porter 1989).

Colony Alate Production. After reaching a certain size, a colony splits its growth resources between worker and alate production (Tschinkel 1993). A queen establishes the nest on a given Julian date with initial colony area and lives a maximum number of days. The model output predicts the total number of alates produced by a colony during its lifetime.

Temperature Data. Data were from National Oceanic and Atmosphere Administration CD-ROMs. Two types of measurements were used: a) direct soil daily maximum and minimum temperature values at 10 cm depth from 137 total stations; and b) daily maximum and minimum air temperatures from 4,537 total stations. Formulas were applied to calculate soil temperatures from air temperatures (Chang et al. 1994, Kluender et al. 1993). Soil temperatures at 10 cm were used to estimate thermo-regulatory movements of a colony. For each station, the most recent temperature trajectories and the corresponding 9 years of data were used to estimate colony growth, development and total female alate production.

Adjusting for Uncertainty. To account for considerable inter-station variability in alate production, five circular areas (radius = 58 km, encompassing approximately 10 weather stations) on the northern limit of RIFA range expansion were used to evaluate uncertainty in our estimates and help predict future range expansion. Four zones of potential range expansion were generated:

(1) Certain zone of colony proliferation success. The average alate production for the 10 sites within each circle was found. The minimum value among these averages appeared in the Tennessee circle (3900; the other values were 4700 and 4600 for two circles in Arkansas, and 4300 and 5200 for two in Oklahoma). This number has important ecological meaning because it gives an estimate of the minimum alate production necessary for a queen to reproduce herself under field conditions. All currently non-infested areas that had total alate production greater than 3900 are the first candidates for future infestation. This is a 'conservative' forecast because it is based on the current RIFA range and average alate production in calibration areas.

(2) Possible zone of colony proliferation success. This more liberal zone was calculated as equal to the average of the minimum values found in each calibration circle, a value of 2100.

(3) Undemonstrated zone of minimum alate production. In this zone alate production was less than 2100, but grater than 0. It is important to note that RIFA colonies in this "undemonstrated" region and even in the "possible" region may not actually be able to produce the numbers of alates predicted if persistent winter kills reduce their ability to compete with native ants that are better adapted to cooler climates.

(4) Improbable zone with zero alate production. This designation, of course, depends on the accuracy of our estimates of cold coma mortality for the RIFA.

Rainfall Influences. Arid or semi-arid conditions should also hamper the RIFA advance because of low habitat productivity and its possible direct affects on colony founding. Since there are no reliable data of this kind, a precipitation threshold of 510 mm/yr was established as a reasonable value limiting RIFA range. This value corresponds to a semi-arid region in southern Texas (near Laredo) where RIFA have been reported to survive in natural mesquite scrub lands (Gilbert, personal communication). However, RIFA are known to do well in arid areas that are irrigated or adjacent to natural water sources (Anon 1999, MacKay and Fagerlund 1997).

RESULTS AND DISCUSSION

The model was run for all 4,537 station locations and average alate production was calculated for each point. Annual precipitation was obtained for each point. Figure 1 illustrates the results of the expanded model and includes predicted RIFA female alate production along with an indication of whether or not there is sufficient rainfall for colony survival (greater than 510 mm/yr). Red circles indicate sites of certain infestation (more than 3900 female alates produced). The green circles are sites of possible infestation (between 2100 and 3900 female alates). The blue circles depict sites in the model with cold temperatures at which fire ants have not demonstrated their ability to survive (up to 2100 female alates; beyond the liberal and conservative estimates defined by the model). Turquoise circles correspond to sites with no predicted alate production where success is very improbable. The current USDA quarantine (June 1999) area is shown in dark gray. Open circles show model calibration areas. Three inserts show more detail in northern California, Maryland, Delaware, and the calibration areas of Oklahoma and Arkansas.

Coverage of the current fire ant quarantine zone with red circles confirms the selection of calibration areas in the most northern part of the current range. Green circles occur primarily in a transitional zone where red, green, and blue stations are mixed. The reason for this "fuzzy border" is the spatial heterogeneity of weather data from these areas. These temperature variations are indicative of numerous and varied spatial situations which involve such things as elevation, vegetation, aspect, slope, etc. Predictions in this border area could be refined with access to more complete data sources.

Within the "certain" zone, the model predicts large range extensions of the red imported fire ant in several regions of the United States. The model predicts 120-150 km northern expansion in Oklahoma and Arkansas, and 80-100 km northern expansion into Tennessee. It is important to note that these predictions are for the red imported fire ant. Black and hybrid fire ants may be capable of surviving even colder winters.

The model predicts considerable expansion of the current RIFA range across the United States, mainly along the coast of Virginia, western parts of Texas, and wide regions of California, New Mexico, Arizona and Oregon. Even Washington, Delaware and Maryland may be able to support fire ant populations at some sites. Low precipitation values will almost certainly restrict fire ant propagation in many natural habitats between western Texas and eastern California. However, areas along watercourses and hundreds of thousands of hectares of irrigated land and urban areas are susceptible to infestation. Additional data delimiting irrigated tracts and water sources are necessary to refine predictions for specific areas where rainfall is limited.

GIS provides tools to clearly illustrate the results of model predictions at more than 4500 locations. Relationships between colony development, temperature and precipitation create complex situations that can be easily visualized using GIS.

ACKNOWLEDGMENTS

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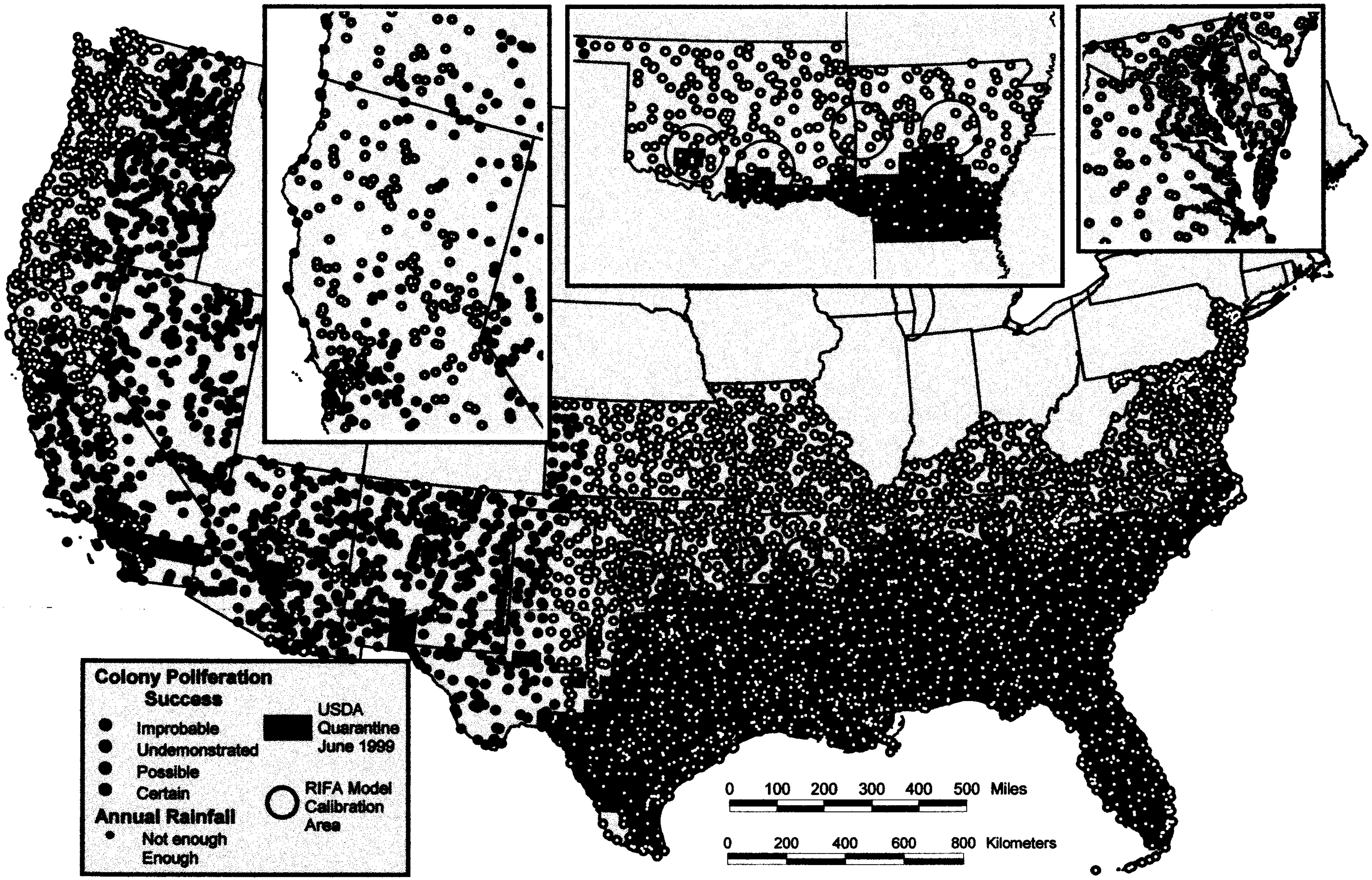

Figure 1. Colony poliferation success based on female alate production.

FASIMS 2000 – AN UPDATE ON THE FIRE ANT SPATIAL INFORMATION MANAGEMENT SYSTEM

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Under the Texas Fire Ant Research and Management Plan, the existing knowledge base for the red imported fire (Solenopsis *invicta* Buren) ant has substantially broadened due to three related programs dealing with: (i) research, (ii) community wide management, and (iii) survey, quarantine and regulation. FASIMS (Fire Ant Spatial Information Management System), originally conceived as a vehicle for distributing components of this knowledge base, has grown to provide elements for database building (Texas Ant Voucher Tracking System), and distribution of nursery quarantine compliance information. Interaction with the system is accomplished entirely through an Internet browser interface to real-time, database driven queries, updates, reports and smart maps.

During the first year of the program, evaluation of the scope and bounds of the Imported Fire Ant Survey (SURVEY) identified seven separate components for inclusion: (i) survey for quarantine regulations, (ii) survey to define distribution and abundance of extant populations of fire ants, (iii) survey for native and exotic species of ants, (iv) survey to evaluate efficacy of management programs in general, (v) survey to evaluate effectiveness of the community management program, (vi) survey to evaluate the impact of released biological control agents, and (vii) create an efficient specimen vouchering system. Based upon these seven components, a general system structure for FASIMS was developed. Upon completion of a prototype system accommodating new data collected as part of the Texas Imported Fire Ant Research and Management Plan, focus was directed toward Internet delivery of FASIMS.

The refinement of Intergraph's GeoMedia Web Map 3.08 software has greatly simplified the task of integrating the GIS and database components (ESRI ArcView® Shape, Microsoft Access®) and standard web browsers. Major developmental tasks centered on issues associated with (i) multiple levels of user access and security, (ii) database access, and (iii) human factors engineering. Two separate branches of access provide public views of real-time smart maps, and administrative views of database tables. Within each of these branches, user accounts provide multiple levels of access.

FASIMS is housed on a Web Server operating Windows NT Server 4.08 located in the Knowledge Engineering Laboratory at Texas A&M University. Users address the system via the Internet using Internet Explorer 4.08 or Netscape Navigator 4.68 (minimum configuration).

Users interact with the database through questionnaire forms and queries to each of the modules result in real-time, database-driven maps. In addition to conventional attribute queries, interactive vector maps (enabled by GeoMedia Web Map®) allow the user to guide queries based upon map features. Capability for scientists participating in the SURVEY to update the database through the Texas Ant Voucher System enables the database to be a living document. Thus the system constantly migrates toward more comprehensive coverage of ant records across Texas. As new records accumulate, queries of the SURVEY database support various research projects. Finally, state regulatory agents can monitor quarantine compliance for nurseries through the quarantine module. With the proper support, this system is fully expandable to the entire fire ant infested region.

FASIMS is a knowledge-based system constructed using commercially available software and hardware components. Providing the system through the Internet in a thin-client interface limits impacts of component version upgrades, data format incompatibilities, and general system maintenance. Also, the user interface through the standard web browser eliminates the need for client software instruction.

Funding for FASIMS is provided by the Texas Fire Ant Research and Management Plan. The site can be found at http://fasims.tamu.edu.

WINTER TEMPERATURE OBSERVATIONS WITHIN RED IMPORTED FIRE ANT MOUNDS IN SOUTHERN ARKANSAS

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Like most poikilotherms, red imported fire ant ***(Solenopsis invicta* Buren)** life is centered around temperature. Temperature has significant effects on fire ant foraging, metabolism, reproduction, and range expansion (Wheeler, 1910; Vinson and Greenberg, 1986; Porter and Tschinkel, 1993; Thompson et al., 1999). Since first appearing in Alabama, range expansion of *S. invicta* has been impressive (Callcott and Collins, 1996). After sweeping through much of the southeast, *S. invicta* is still expanding north and westward. Recently fire ants have been discovered in California, Arizona, and Nevada (USDA-APHIS web site). Models have been used to describe fire ant range expansion, and soil temperatures are an important input parameter (Korzukhin and Porter, 1994).

Nest construction appears to be a significant factor in explaining *S. invicta's* expansion. Fire ants have somewhat limited physiological adaptations for cold-hardiness (Francke et al., 1986). Successful colony growth of *S. invicta* is limited by a relatively narrow temperature range (Porter, 1988). This is somewhat similar to honeybees, who also have a narrow temperature range for normal growth (about 32-36°C) and a high minimum temperature necessary for brood development (Seeley and Heinrich, 1981). This would suggest that *S. invicta* has a somewhat limited ability to thermoregulate, so it needs to construct earthen mounds that serve as solar collectors to maintain its preferred temperatures (Porter and Tschinkel, 1993).

Fire ant colonies established in the laboratory cease colony growth when the temperature drops below 24°C, or rises above 36°C, with maximum growth occurring around 32°C (O'Neal and Markin, 1975; Cokendolpher and Francke, 1985; Porter, 1988). In the field, colony growth occurs at soil temperatures much cooler than those measured in the laboratory, with brood appearing in colonies when mean weekly soil temperatures (at 5cm) have risen above 10°C (Markin et al., 1974). These observations suggest that the fire ant mound is a truly marvelous creation, enabling *S. invicta* to survive and prosper in cooler climates. This experiment was designed to measure mound temperatures within several fire ant mounds on a continual basis for diverse southern Arkansas winter days.

Materials and Methods

Two types of programable data logging temperature devices produced by Onset Computer Corp., 470 MacArthur Blvd., Bourne, MA 02532, were used. The first, StowAway[a] TidbiT[a] XT TBXT08, -20°C, +70°C, 148971 temperature loggers, have a remote thermocouple that makes them suitable for insertion into fire ant mounds. The second, Optic StowAway[a] WTA08, -39°C, +75°C, 146965 temperature loggers, have an internal thermocouple, making them suitable for recording temperature in more accessible locations. Boxcar® Pro 3.5 for windows software was used to program all probes and transfer data from probes to the computer. Temperature probe calibration was factory preset with error rates of ± 0.4°C at 21°C.

Three imported fire ant mounds of moderate size (15 - 21 cm in height and 30 - 40 cm in diameter) were selected in a large field near Monticello, Arkansas. Temperature probes were placed in the approximate mid-line of each mound at three depths;

~ 2.5 cm below the mound apex;

~ 18 cm below the mound apex, or roughly level with the surrounding ground; and

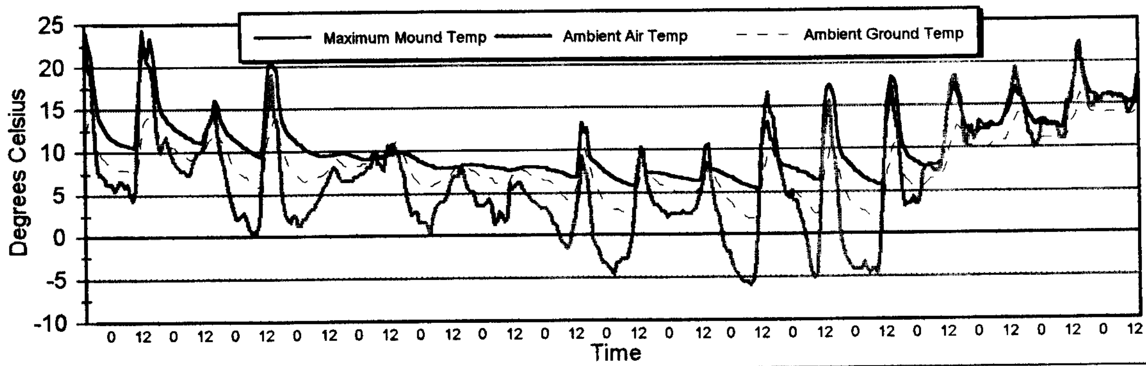
~ 33 cm below the mound apex, or roughly 15 cm below the surrounding ground level. Additionally, one set of temperature probes was placed nearby to measure ambient air temperature at 10 cm above the ground surface, and soil temperature at 5 cm below ground in undisturbed soil.

Temperatures were recorded every hour for 18 days from December 19, 1997 until January 5, 1998. Precipitation measurements were obtained for the Monticello national weather service recording station from the NOAA web-site at http://www.nndc.noaa.gov/. Sky conditions were estimated by calculating the maximum mound temperature for the daytime hours from 8:00 AM to 5:00 PM and subtracting the ambient air temperature. If there was a 2 degree or greater positive difference, then it was assumed to be a clear weather day and somewhat 'sunny', if not then an 'overcast' condition was assumed. Assigned weather conditions began at 8:00 AM and carried over into the next day until 7:00 AM. Degree-days were calculated using two temperatures to estimate minor worker development; 17°C was used for the hypothetical minimum temperature for brood development and 24°C for the measured minimum temperature (Porter, 1988).

Results and Discussion

As expected, ambient air temperature fluctuated depending on the hour of day (fig. 1). Ambient ground temperature at 5 cm also fluctuated with the rising and setting of the sun but not as much as air temperature (fig. 1). Inside the three fire ant mounds, at the 2.5 cm depth, the temperature was similar to the ambient air temperature, but generally stayed

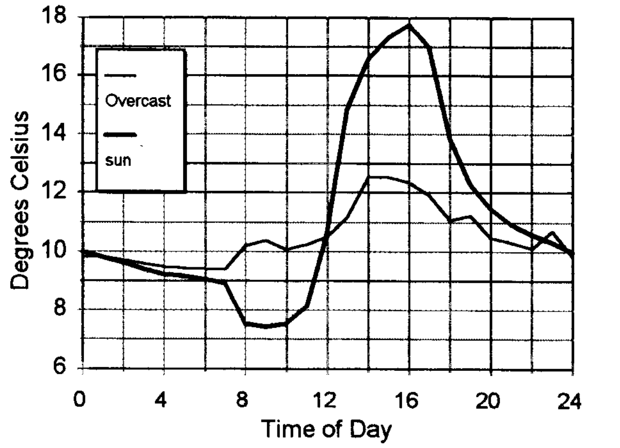
Fig. 1. Mean recorded ambient air, ambient ground, and maximum mound temperature for 3 red imported fireant mounds in southern Arkansas.



1-2°C warmer (fig. 1).

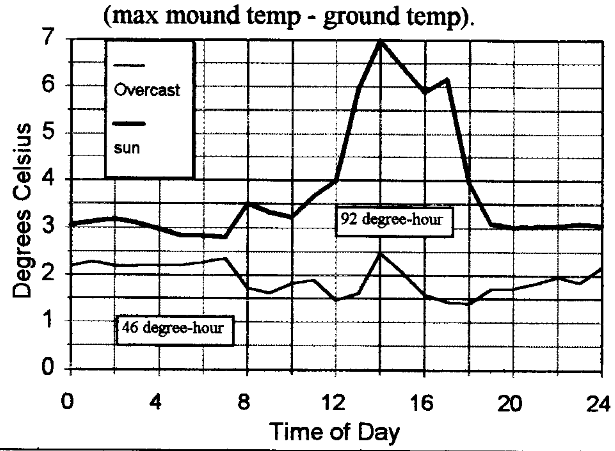
Temperature swings were dampened at the deeper regions of the mounds, as would be expected. Figure 2 depicts the mean maximum temperatures in the mounds over the 18 day period with respect to weather conditions (sunny vs overcast). The most interesting measurements occurred when the maximum mound temperature at any hour is compared to the ambient ground temperatures (fig. 3).

Fig. 2. Mean maximum mound temperatures.



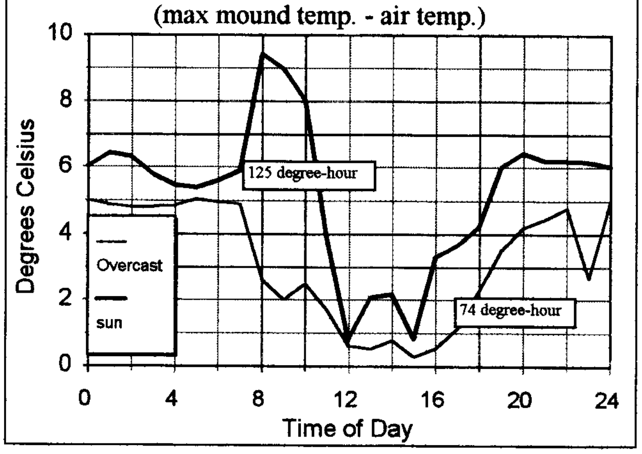
The temperature gain provided to the colony by the fire ant mound is impressive, ranging from about 2.5°C ± 1.2 (P =0.05) at 12:00 PM on overcast days to a 6.9°C ± 1.8 (P =0.05) gain at 2:00 PM on sunny days. Another advantage is that the temperature gain is carried over into the evening hours as well, keeping temperatures over 2°C warmer than the surrounding soil. Perhaps this is due to an insulating effect provided by the maze of tunnels within the mound.

Fig. 3. Mean temperature gain in mounds (max mound temp - ground temp).



Mean degree-hours were calculated for the temperature gain provided by the mound over ambient soil conditions (46 degree-hours for overcast vs 92 degree-hours for sunny conditions). Comparing mean maximum mound temperatures to ambient air temperatures (fig. 4) with respect to weather conditions, gives similar results as the ground comparison, but with greater differences.

Fig. 4. Mean temperature gain in mounds (max mound temp. - air temp.)



Because of the winter conditions, we did not expect a large number of degree-days to be accumulated during the experiment. When we used a hypothetical minimum temperature of 17°C for minor worker brood development, 12.7 degree-days were accumulated. However, no degree-days were recorded when we used 24°C as the minimum developmental temperature.

While the temperatures recorded in this experiment do not support growth of a fire ant colony, it does demonstrate the importance of their mounds for regulating temperatures. Living in mounds enables *S. invicta* to lengthen their growing season. If the theoretical minimum temperature of 17°C is in fact the true minimum, then even though December is typically one of the colder months in Arkansas, measured maximum mound temperatures surpass the 17°C benchmark and are not too far from the previously measured 24°C required for colony growth in the laboratory.

Acknowledgments

Dr. Larry Claypool, Oklahoma State University, provided statistical advice. Mr. Kenny Davis, Univ. of Arkansas at Monticello provided help with experiment setup. This research was funded by USDA, APHIS Grant 97-8100-0229-GR and does not necessarily express APHIS's views.

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RESPONSE OF RED IMPORTED FIRE ANT (*SOLENOPSIS INVICTA* BUREN) COLONIES TO STATIC ELECTRICAL DEVICES

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Abstract A three-chamber experimental apparatus was constructed to determine preferential movements of red imported fire ant colonies towards or away from an activated static electrical device (SED). Colonies of **RIFA** adopted brood boxes near electrified SED and alarm pheromone environments significantly more often than identical brood boxes near non-electrified SED.

The red imported fire ant (RIFA), ***Solenopsis invicta*** **Buren**, has long been an economical problem for electrical companies in Texas. This problem has generated numerous studies with RIFA and their effects on electrical devices. Vinson and Mackay (1990) were among the first to document damage to Texas Highway Department's signal cabinets and to residential air-conditioning units. Vinson and Mackay's (1990) study consisted of a survey of the Bryan/College Station, Texas, area which revealed the presence of RIFA in 75% of the signal cabinets that were not treated with insecticides. In 20% of the cabinets the ants had caused problems that required treatment. RIFA accumulate in electrical equipment and cause damage by grounding and shorting-out circuits (Vinson and Mackay 1990). Slowik and Thorvilson's (1996) study determined that RIFA contained subcuticular iron-containing tissues, which may be used by **RIFA** as a magnetic field sensing device. In 1997 Slowik, Green and Thorvilson used magnetic resonance imaging (MRI) to determine the presence internal magnetism in **RIFA.** Slowik Thorvilson and Green (1996) used wire-set experiments to determine that **RIFA** were not attracted to electrical fields generated by active electrical equipment. Rather, ants were attracted to bare, electrically active wires and when in contact were electrocuted. During shock, **RIFA** gaster-flagged that is, raised the abdomen and released alarm pheromones. Alarm pheromones caused the ants to aggregate around an electrical stimulus. Ipser (1998) took the previous studies to a new level. In conjunction with Texas Tech engineers, Ipser, Thorvilson, and Green constructed a static electrical device (SED) with optimal characteristics to prevent **RIFA** from invading electrical equipment. In addition to determining optimal voltage **(70Vac)**, RIFA attraction to an activated SED was quantified to determine if the device had repellency qualities. The SED consisted of a silicon plate and diodes that regulated voltage to conductors that when bridged by a **RIFA** would induce gaster-flagging and aggregation.

The objective of this study is to determine whether entire colonies would relocate towards or away from an electrically charged SED.

Materials and Methods

Red imported fire ant colonies were collected in Lubbock, Texas, on 11 January 2000, separated from the soil by dripping water into plastic pails, and established in 29 x 15 x 8-cm plastic containers with **Fluon®** (Northern Products, Woonsocket, RI) along the edges to prevent escape. Within each container, a plastic brood nest (9-cm-dia. petri dish with dental plaster) was placed to provide high humidity for optimal survival and for brood rearing. Colonies were provided daily with water using a test tube and cotton plug and were supplied with food consisting of dog food or jelly.

A three-chamber experimental apparatus (Fig. 1.) was constructed to test if preferential movements of RIFA colonies towards or away from an electrified SED existed. A 29 x 15 x 8-cm plastic tray was placed between two 55 x 43 x 13-cm trays and was connected to each larger tray by a 15-cm Tygon® tube. Ramps of triangular pieces of paper and masking tape were constructed to allow easy access for ants to the connecting tubes. No food or water source was available in the center tray. In each larger tray, a SED was placed 5-cm from each access ramp, and a plastic brood box was placed 25 cm behind each SED.

At the beginning of each experimental trial, a RIFA colony with brood was poured into the center, smaller tray, and ants were allowed to freely disperse and explore the habitat. Ants had equal access to all three trays via tubing corridors. At that point electricity was supplied to one randomly chosen SED, and the other SED was left unplugged (control treatment). Observations were made of colony behavior and movement, and the location of the brood box in which a colony eventually inhabited was recorded.

Before each trial (replication), new paper ramps were constructed, and SED's, trays, and tubing were cleaned and disinfected with 70% ethyl alcohol. Power to a SED was randomly assigned, and the trays were rotated to random, cardinal, compass directions. Trials were run under continuous illumination and at a temperature of 24° C. Fifteen replications of this experiment were made. A time-lapse video recording was made of one trial to determine the rate of colony habitation of a brood box.

Data were evaluated as a 2x2 contingency table using Chi-square analysis ($P \leq 0.05$) to test the null hypothesis that choice of brood boxes was irrespective of SED status and subsequent chemical environment. The tested hypothesis assumed that the colonies would establish in brood boxes in a 50:50 percent ratio.

Results

In all trials, colonies did not fracture, that is, move into both brood boxes to produce sub-colonies. Rather, colonies remained intact and moved into one of the two brood boxes. Numerous ants were observed crawling upon each SED, and many ants gaster-flagged when they bridged the conductive material and received a 60-volt shock from an electrified SED. Typically, colonies reacted to gaster-flagging by aggregating near an electrified SED. Defensive behaviors were not elicited by ants exploring an nonelectrified SED.

Colonies inhabited brood boxes near an electrified SED 73.3% of the trials (11 out of 15). This percentage was significantly greater than that expected ($\chi^2 = 6.53$; df = 14; $P = 0.011$). The single time lapse video measured 504 minutes (8.4 hrs) for a colony to move into a brood box.

Discussion

RIFA colonies preferentially adopted brood boxes near alarm pheromone environments caused by gaster-flagging on electrified SED. Perhaps the aggregation and defensive behaviors caused colonies to "hunker down" in the nearest suitable habitat, a brood box. Additional trials of this experiment will be completed, and numerous time-lapse videos will document rate of colony establishment in brood boxes.

Because of the results, our opinions about the repellency of our SED may be revised. An opposite working hypothesis may be adopted; that is, to use SED technology to construct capture devices and to divert RIFA colonies from sensitive electrical equipment such as transformers, traffic signal switch boxes, air-conditioning units, and water pumps.

Acknowledgment

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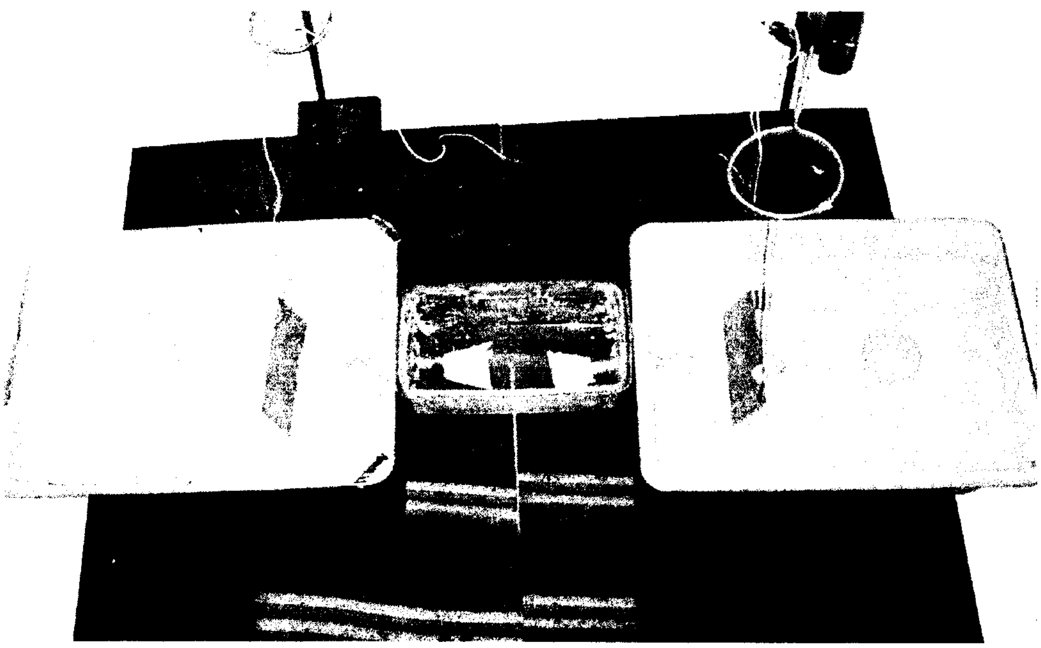

Figure 1. Three-chamber experiment designed to test preferential movements of the red imported fire ant towards or away from an active static electrical device.

TEE ECONOMIC IMPACT OF FIRE ANTS ON METROPLEXES IN TEXAS

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The imported fire ant ***(Solenopsis invicta*** **Buren)** has become a major economic pest to various sectors of the Texas economy. In order to determine the economic impact of this pest on selected urban areas, an economic study was conducted in 1998-1999 in the five metroplexes of Austin, Dallas, Fort Worth, San Antonio, and Houston to estimate the costs of controlling and managing fire ants. The main purpose of this study was to estimate the annual economic impact of the fire ant on the households, schools, cities, and golf courses for the aforementioned metroplexes. Other sectors within the urban areas are affected, but this study shows the major impacted sectors that interfere with the human activities in living areas, work areas, and recreational areas.

This research study was conducted by the Department of Agricultural Economics through the Texas Agricultural Experiment Station (TAES) and the Texas Agricultural Extension Service (TAEX) of the Texas A&M University system. The principal sponsor was the Texas Fire Ant Initiative with the funds from the Texas Department of Agriculture's portion of these funds. The Texas Fire Ant Economic Impact study received much assistance and advice from the overall Fire Ant Research Team in the early stages of this study. This assistance helped in the development of the research objectives and the survey instruments. Further information is at **http://fireant.tamu.edu.**

Estimated costs for controlling the imported fire ant from five Texas metroplexes:

Expenditures per Metroplex
- Austin $61 million
- Dallas $121 million
- Fort Worth $75 million
- Houston $122 million
- San Antonio $202 million

Expense Categories and Costs
- Treatment $302 million
- Repair $81 million
- Replacement $152 million
- Medical $47 million
- Electrical $111 million

Expenditures per Sector
- Households $526 million
- Golf Courses $29 million
- Schools $25 million
- Cities $112 million

Conclusion

In 1998 it was estimated that in the five Texas metroplexes studied, the imported fire ant costs each homeowner $151, each school $4,954, and each golf course $63,495. The cities also experienced substantial damage to their electrical systems. The electrical category includes costs of electrical, cable, and telephone companies. Total metroplex expenditures differ from those by sector due to these electrical costs and rounding variations. Expenditures per metroplex only included expenses of the four major sectors.

ECONOMIC IMPACT OF FIRE ANTS IN ALABAMA CATTLE OPERATIONS

Kathy Flanders, Extension Entomologist, Auburn University, & Jesse LaPrade, Extension Environmental Specialist and PIAP Liaison, Alabama Cooperative Extension System

The Alabama 1998 Statewide Forage Crop (Hay and Pasture) Producer Survey was conducted by the Alabama Agricultural Statistics Service for the Alabama Pesticide Impact Program. This survey was mailed to a subset of Alabama cattlemen. As part of that survey, respondents were asked to quantify costs associated with imported fire ants and their control in 1998.

1,056 useable reports were obtained from the 2,860 questionnaires that were mailed. The average cattleman in the survey had 422 acres of total land, with 186 **A** of perennial grass pastures and 81 **A** of hayfields. Fifty-nine percent of the cattlemen had less than 100 head of cattle and calves, 37% had 100-299 head, and **4%** had 300 or more head. It is estimated that there are 2,870,000 A of pasture, and 1,157,000 **A** of hayfields in Alabama (Ball 1996). Most of the costs associated with fire ants came from damage to equipment, followed by the cost of poisons and baits, and by losses due to livestock and poultry (Table 1).

Table 1. Economic Loss Estimates and Cost of Controls for Imported Fire Ants in Alabama Cattle Operations.

Item (No. respondents)	Percent of respondents in each cost category				
	$0	**$1-99**	**$100-499**	**$500-999**	**≥$1000**
Damage to equipment, such as mowers, hay balers, combines (921)	**47**	14	19	14	6
	$0	**$1-99**	**$100-499**	**≥$500**	
Poisons, baits or other materials (985)	39	36	21	4	
Injury or loss of livestock and poultry (872)	78	8	7	7	
	$0	**$1-99**	**≥$100**		
Illness or allergic reactions to stings to self, family members, or employees (890)	80	16	4		
Damage to electrical wiring and motors (867)	**77**	14	9		

Median losses due to equipment damage fell between $1-99, but 20 percent of cattlemen indicated they experienced losses of $500 or more. Median expenditure on fire ant control materials fell between $1-99, with 4 percent of cattlemen spending $500 or more. Most cattlemen did not report any **injury** to livestock or poultry (78%). However, 7% reported livestock losses of $500 or more. Most cattlemen did not have any medical costs related to fire ants (80%). Most cattlemen reported no damage to electrical wiring and motors (77%).

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TOXICITY OF A ALGINATE MYCELIAL PELLET FORMULATION OF *BEAUVERIA BASSIANA* TO *FIVE* WEST TEXAS NATIVE ANT SPECIES

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Abstract

An alginate mycelial pellet formulation of *Beauveria bassiana* shown to be toxic to *Solenopsis invicta* Buren (Bextine, 1998) was tested against five species of ants indigenous to the High Plains of Western Texas to determine native ant susceptibility to the fungus. *Monomorium minimum, Forelius pruinosis, Camponotus vicinus, Pogonomyrmex barbatus,* and *Pheidole sp.* as well as *Solenopsis invicta* were exposed to *Beauveria bassiana* conidia under laboratory conditions. During the first trial, significantly greater percent mortality was found in ants exposed to the fungus than in ants in the control in all species tested, except in *Pheidole sp.* During the second trial, no significant differences between mortality of exposed ants and ants in the control was detected in any species. These results indicate that further research needs to be done to fully determine the toxicity of *Beauveria bassiana* to native ant species.

Introduction

Beauveria bassiana is an entomopathenogenic fungus that occurs worldwide and has probably one of the broadest ranges of all such fungi. It is a primary cause of infection of soil-dwelling immature insects (Schmid-Hempel 1998.) Historically *Beauveria bassiana* has been studied as a biological control agent of *Solenopsis richteri* and *Solenopsis invicta* (Broome et al., 1976; Pereira et al., 1993; Siebeneicher et al., 1992) and Bextine (1998) found that an alginate mycelial pellet formulation of the fungus was effective in the control of *Solenopsis invicta* invicta. Because, *Beauveria bassiana* is known to infect several ant species, (Pereira & Stimac 1997), and due to its effectiveness in controlling the red imported fire ant, concerns have been raised about the effects of *Beauveria bassiana* on native ant species. The objective of this study was to examine the effects of *Beauveria bassiana* on native ant species of western Texas to determine its pathenogenicity in laboratory bioassays.

Materials and Methods

Maintenance of Laboratorv Colonies

Colonies of ants were collected from Lubbock County in the Texas High Plains area. Ant colonies were dug from their natural habitats, and soil was dried in the laboratory until all ants had moved into test tubes plugged with cotton and filled with water. As ants were removed from soil, they were placed into plastic boxes with Fluon® (Northern Products, Inc., Woonsocket, RI) around the edges to prevent escape. Ants were fed canned cat food, fresh hit, and honey water (1:3, honey:water.) A constant supply of water was provided.

Trial One

Conidial Growth. Conidia for use in bioassays were grown using milled fines (<841 microns) from *Beauveria bassiana* alginate pellets produced at Texas Tech University, Lubbock, Texas. Sterile 55-mm, filter paper (#1 Whatman®, Maidstone, England) was placed inside 60 x 15-mm, sterile, plastic petri dishes (Fisher Scientific®) and moistened to saturation with sterile water. Approximately 0.5 g of fines was placed on the surface of the moistened filter paper, and petri dishes were closed and sealed with Parafilm® (American National Can™, Greenwich, Ct.). Fines were incubated in petri dishes for seven days to allow production of conidia. Petri dishes were maintained at a temperature of approximately 26° C.

Bioassay. Initial efficacy tests were performed on five species of native ants and the red imported fire ant, *Solenopsis invicta* Buren, to determine species susceptibility to *Beauveria bassiana*. Native ant species used in efficacy trials were *Monomorium minimum, Forelius pruinosus, Pogonomyrmex barbatus, Pheidole sp.*, and *Camponotus vicinus*. Tests were conducted in the bottom portion of 100 x 15-mm plastic petri dishes (Becton Dickinson, Franklin Lakes, NJ) that had Fluon® around the edges to prevent ant escape. Three-tenths gram of conidia-producing *Beauveria bassiana* fines was spread uniformly into each petri dish so that ants were inoculated by contact with conidia. Ten randomly selected ants from a colony were introduced into each treatment dish with conidia, and ten ants from the same colony were placed in a treatment dish without fungus. *Solenopsis invicta* and *Monomorium minimum* had three colony replicates, *Forelius pruinosus, Pogonomyrmex barbatus*, and *Camponotus vicinus* had two colony replicates, and *Pheidole spp.* had one colony replicate. Ants were supplied with water from a test tube plugged with cotton and with artificial diet (Bhatkar and Whitcomb, 1970). Bioassay petri dishes were placed in an environator at 26.7°C and monitored daily for ant mortality.

To determine if fungal growth would occur from the cadavers, dead ants were removed from petri dishes and surface-sterilized in 10% water solution of bleach (5.25% sodium hypochlorite, Great Value™, Walmart, Ind®, Bentonville, AR) for two minutes, then rinsed in sterile water. Each ant was subsequently placed in an individual cell of a sterile tissue culture plate (Falcon™, Le Pont De Clark, France) on sterile cotton saturated with sterile water. Tissue culture plate lids were used to close the plate, and the edges were sealed with Parafilm®. Plates were incubated in an environator at 26.7° for two weeks. Ants were then visually inspected for *Beauveria bassiana* conidiogenesis and conidia. Data was analyzed with SAS for Windows software (SAS, Cary, NC) using paired t-tests ($P \leq 0.05$).

Trial Two

Conidial Growth. Conidia for use in the second bioassay procedure were grown using the same procedure as in trial one, with the exception that after conidiogenesis, the milled fines were removed from petri dishes along with conidia and allowed to air dry for 24 hours or until all moisture was evaporated from the fines. Dried fines were ground to a homogenous consistancy using a mortar and pestle. For use in the control treatment, unprocessed wheat bran (Hodgson Mill®, Teutopolis, IL) was ground in a coffee grinder to a consistency that was visually equivalent to that of the ground mycelia with conidia. Wheat bran was used because it is a main ingredient of the alginate pellet formulation of *Beauveria bassiana*.

Bioassay. The same bioassay set-up was used as in trial one with a few exceptions. Two-tenths gram of dried conidia-producing *Beauveria bassiana* fines was spread uniformly into each petri dish. Ten randomly chosen ants from a colony were placed into the petri dish with the conidia. Petri dishes containing ten ants from the same colony and 0.2g gram of ground wheat bran were used as control. Ant species were replicated three times with one set of 10 randomly selected ants from three different colonies. The only exception was with the species *Forelius pruinosus* because only one colony was available for three replications. Ants were maintained as stated above, and bioassay petri dishes were held at 24°C.

To determine if fungal growth would occur from the cadavers, dead ants were removed from petri dishes daily and surface-sterilized in 10% water solution of bleach (5.25% sodium hypochlorite) for two minutes, then rinsed in sterile water. Triton 100X (5 drops) was used in both bleach and water as a wetting agent. Dead ants were then placed in sterile petri dishes with filter paper on the bottom that had been moistened to saturation with sterile water. Petri dish lids were used to close the dishes, and the edges were sealed with Parafilm®. Petri dishes were allowed to incubate at 24°C for two weeks. Ants were then visually inspected for *Beauveria bassiana* conidiogenesis and conidia. If *Beauveria bassiana* appeared to be present, it was plated onto Sabouraud's Dextrose Agar for growth and further identification. Data was analyzed using a paired t-test ($P \leq 0.05$) with software from SAS.

Results and Discussion

Trial One

Differences between the percent mortality of the ants exposed to *Beauveria bassiana* and mortality of ants in the control in all species, except *Pheidole sp.* were significant as illustrated in Table 1.1. Furthermore, significant differences were found in the percent of dead ants that showed apparent *Beauveria bassiana* growth after incubation in *Pogonomyrmex sp.*, *Pheidole sp.*, *Camponotus sp.*, and *Solenopsis sp.* (Table 1.1.) Due to a limited number of ants available for study, there were no replications for the *Pheidole sp.* in this experiment, and therefore, conclusions could not be drawn except on an intuitive basis. Mortality in the *Beauveria* treatments appeared to occur earlier within the 14-day trial period than did mortality within the controls (Figures 1.1 to 1.6). Whereas results suggest that *Beauveria bassiana* is highly pathenogenic to native ants in the laboratory bioassays, significant differences in all species between the treatment and control in the percentage of cadavers that exhibited conidial growth did not occur. Because in most species mortality occurred soon after treatment, suffocation of ants from conidia of the milled *Beauveria bassiana* fines used in the trial may be a plausible explanation. In addition, concern was raised about improper surface sterilization of ants due to the large number of control ants that showed *Beauveria bassiana* growth. These concerns prompted initiation of a second experiment, in which the control treatment included ground wheat germ to account for suffocation. A wetting agent was used to improve surface sterilization.

TABLE 1.1 Trial 1: Mean percent mortality after two weeks of exposure to *Beauveria bassiana* conidia and percent of dead ants with *Beauveria bassiana* fungal growth after two weeks incubation.

	% Mortality(±SD)		**% Dead with Growth(±SD)**	
SPECIES	***B. bassiana***	**Control**	***B. bassiana***	**Control**
Monomorium minimum	81.3(±28.2)a	21.3(±22.0)b	18.4(±19.1)a	12.9(±27.4)a
Forelius pruinosus	86.0(±29.9)a	33.0(±27.9)b	51.5(±42.4)a	17.2(±34.0)a
Pogonomyrmex barbatus	68.0(±37.4)a	32.0(±21.5)b	64.7(±28.7)a	20.2(±28.1)b
Pheidole sp.	82.0(±21.7)a	56.0(±38.5)a	65.6(±39.6)a	0.0(±0.0)b
Camponotus vicinus	62.0(±17.5)a	37.0(±30.6)b	43.2(±46.2)a	0.0(±0.0)b
Solenopsis invicta	99.3(±02.6)a	57.3(±31.5)b	32.2(±23.1)a	13.6(±29.5)b

[a] Means followed by the same letter within a row for % mortality or % dead with growth are not significantly different (paired t-tests; P>0.05)

Trial Two

Trial two showed no significant differences in total percent mortality or percent dead with growth for any species tested (Table 1.2). In all treatments and in all species, mortality reached higher levels than in trial one. However, in the second experiment, in which wheat germ was used in the control, death in the control appeared to occur at shorter intervals than in the first trial in which no wheat germ was used (Figures 2.1-2.6.) These observations suggest mortality in this study may be from suffocation rather than invasion of *Beauveria bassiana* through the ant cuticle. However, high percentages of cadavers in the control exhibited *Beauveria bassiana* growth similar to that of the inoculated treatments, suggesting some form of contamination. Possible sources of contamination may have been laboratory air, apparatus contamination, or indigenous forms of *Beauveria bassiana* within experimental laboratory ant colonies. Moreover, the wheat germ used in this experiment may have been contaminated. Currently, experimentation is underway to determine the exact cause of the fungal growth from control ant cadavers. These factors combined with the differences in the results of between the two trials, make the results of this research inconclusive. Nonetheless, all indications are that native ant species are indeed susceptible to *Beauveria bassiana* at a level comparable to that of *Solenopsis invicta.* Nevertheless, further studies are needed to determine the toxicity effects of *Beauveria bassiana* to native ant species. Further research will compare interspecies susceptibility to *Beauveria bassiana,* including other native ant species. Also, evaluations of native ant species population levels in red imported fire ant-infested habitats are necessary to determine strategies to target red imported fire ants with *Beauveria bassiana* applications and to preserve native ants.

TABLE 1.2 Trial 2: Mean percent mortality after two weeks of exposure to *Beauveria bassiana* conidia and percent of dead ants with *Beauveria bassiana* fungal growth after two weeks incubation.

	% Mortality(±SD)		**% Dead with Growth(±SD)**	
SPECIES	***B. bassiana***	**Control**	***B. bassiana***	**Control**
Monomorium minimum	100.00±0.0)a	86.7(±23.1)a	40.0(±26.5)a	28.9(±18.4)a
Forelius pruinosus	100.0(±0.0)a	90.0(±10.0)a	100.0(±0.0)a	71.8(±19.5)a
Pogonomyrmex barbatus	100.0(±0.0)a	96.7(±05.8)a	33.3(±25.2)a	51.1(±15.4)a
Pheidole sp.	100.0(±0.0)a	70.0(±26.5)a	76.7(±15.3)a	48.6(±14.6)a
Camponotus vicinus	96.7(±05.8)a	50.0(±34.6)a	50.7(±35.1)a	09.5(±08.3)a
Solenopsis invicta	100.0(±0.0)a	80.0(±26.5)a	66.7(±20.8)a	58.9(±25.9)a

[a] Means followed by the same letter within a row for % mortality or % dead with growth are not significantly different. (paired t-tests; P>0.05)

Acknowledgments

The authors acknowledge the support of the Texas Imported Fire Ant Initiative Program for this research.

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Figure 1.1-Trial 1-*Monomorium minimum*: Average % Mortality Over Time

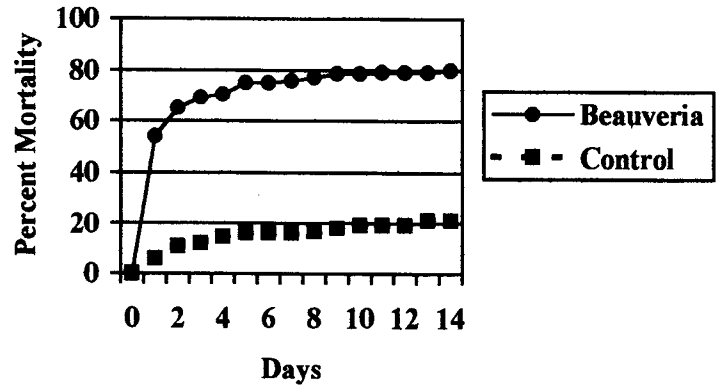


Figure 1.2-Trial 1-*Forelius pruinosus*: Average % Mortality Over time

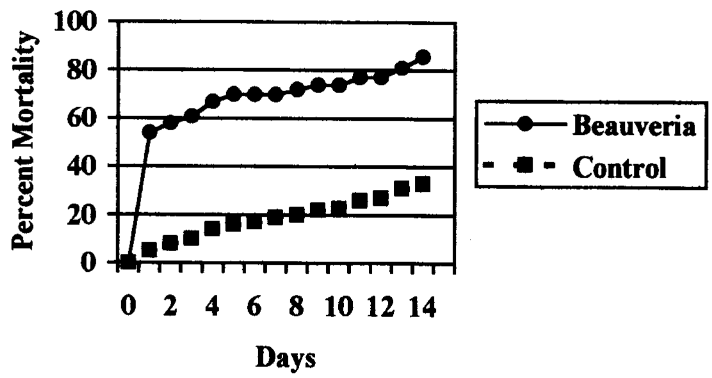


Figure 1.3-Trial 1-*Pogonomyrmex barbatus*: Average % Mortality Over Time

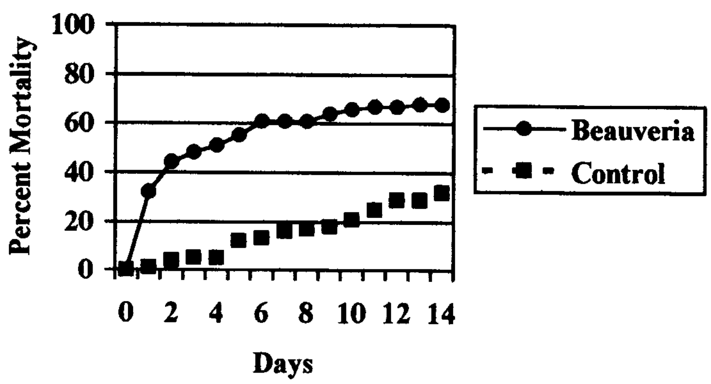


Figure 1.4-Trial 1-*Pheidole sp.* : Average % Mortality Over Time

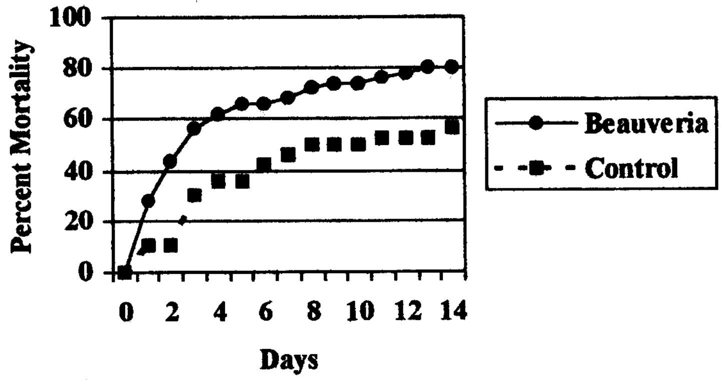


Figure 1.5-Trial 1- *Camponotus vicinus* : Average % Mortality Over Time

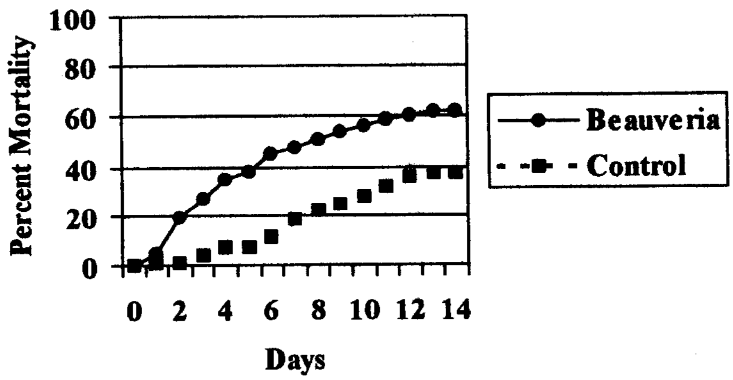


Figure 1.6-Trial 1-*Solenopsis invicta*: Average % Mortality Over Time

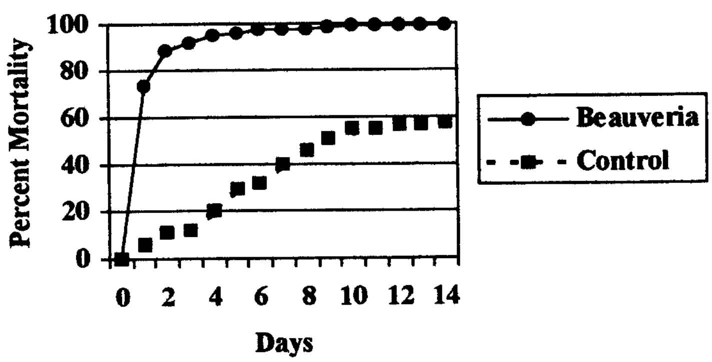


Figure 2.1-Trial 2-*Monomorium minimum*: Average % Mortality Over Time

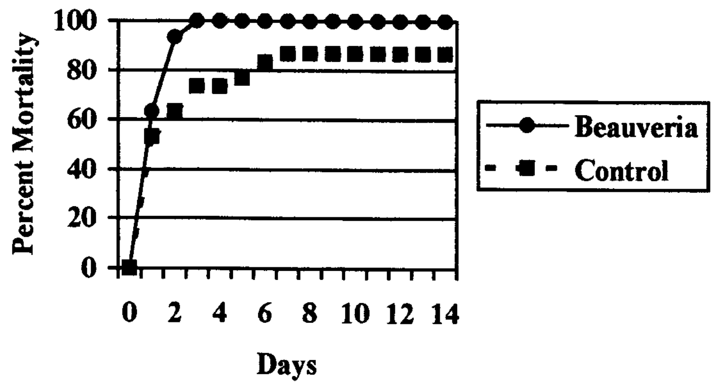


Figure 2.2-Trial 2-*Forelius pruinosus*: Average % Mortality Over Time

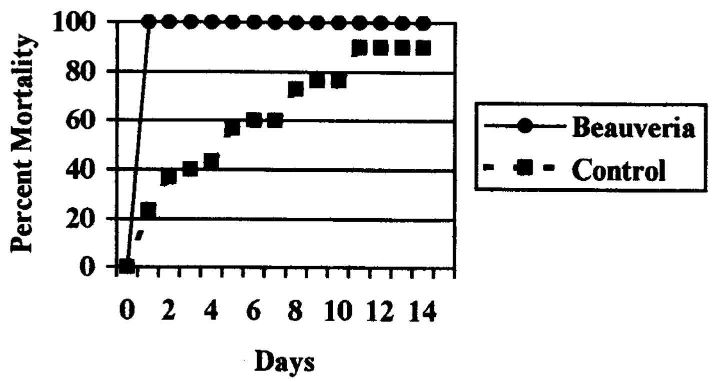


Figure 2.3-Trial 2-*Pogonomyrmex barbatus*: Average % Mortality Over Time

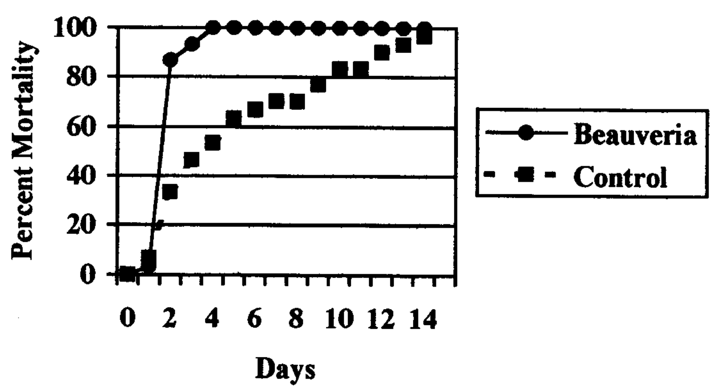


Figure 2.4-Trial 2-*Pheidole sp.* : Average % Mortality Over Time

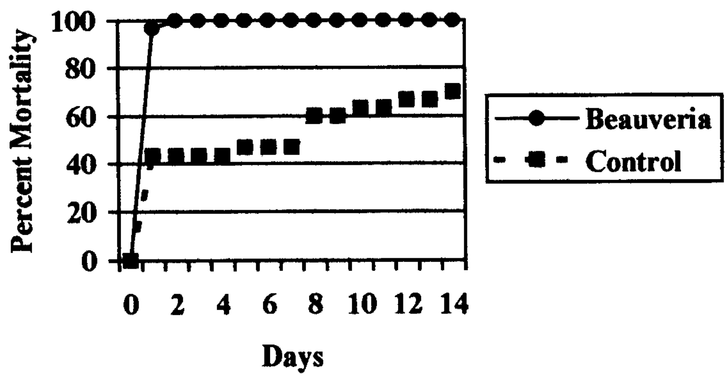


Figure 2.5-Trial 2-*Camponotus vicinus* : Average % Mortality Over Time

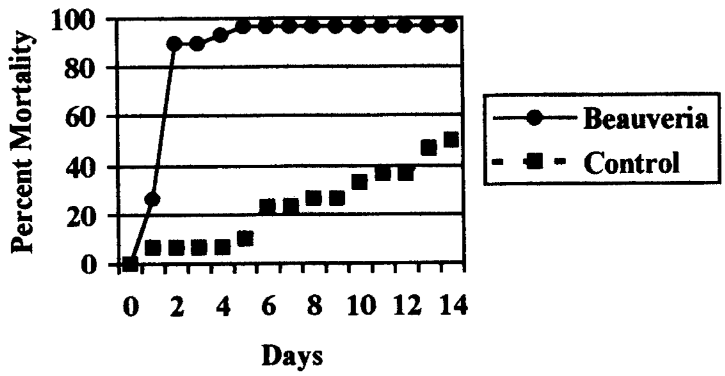
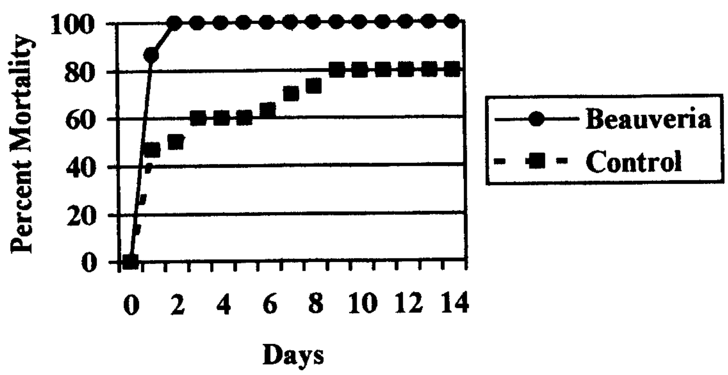


Figure 2.6-Trial 2-*Solenopsis invicta* : Average % Mortality Over Time



EVALUATION OF METHOPRENE IN BERRY CROPS IN ARKANSAS

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Abstract

Extinguish™ (0.5% methoprene) fire ant bait was evaluated against the red imported fire ant, Solenopsis invicta, in strawberry and blackberry plots in Lincoln County, Arkansas. The labeled broadcast rate of 1-1.5 pounds per acre resulted in an overall percent reduction of foraging ants of ca. 40% at 2 months post-treatment.

Introduction

The red imported fire ant, Solenopsis invicta, is a pest insect in over 27 Arkansas counties. Lincoln county in the southeastern part of the state has been impacted by fire ants for a minimum of nine years. Both commercial and private agricultural enterprises have been negatively impacted. Commercial berry production has particularly felt the impact due to the labor intensive, hands-on harvesting techniques.

Commercial strawberries are produced on approximately 250 acres in Arkansas, with a total yearly production of 11,000 cwt. valued at $682,000. Commercial blackberries are produced on approximately 178 acres in Arkansas, with a total yearly production of 2,466 cwt. valued at $184,934 (Arkansas Agricultural Statistics Service).

Until recently pesticide labels have restricted the use of fire ant baits in commercial fruit production. In 1999, the EPA approved the use of methoprene on croplands including---- strawberries and blackberries. The lone restriction is that the bait did not come into contact with the fruit.

Mr. Frank Gibson produces berry crops on 10 acres in Lincoln County (see figure 1). He initially approached the Extension Service about his failure to achieve control of fire ants, and subsequent complaints from his day-laborers. With the recent introduction of the methoprene product, labeled ***Extinguish™***, we decided to test the product on Mr. Gibson's farm.

Materials and Methods

Strawberries and blackberries plots were selected for the demonstration in Lincoln Co. due to grower need for control. Plot size ranged in size from one-eighth to one-quarter acre. Pre-treatment counts were made on the plots on 5120199. Methoprene, marketed under the brand name ***Extinquish™***, was applied at the labeled rate of 1 to 1 ½ pounds per acre using a hand spreader. Post-treatment counts were made on 7/21/99.

In both pre- and post- treatment counts bait stations were placed an approximate equal distance throughout the strawberry, thornless blackberry, and thorned blackberry plots. Counts were made one hour after bait station placement. The number and species of ants were determined for each bait station.

Discussion

Pre-treatment counts in the strawberry plot using bait stations averaged 58.1 fire ants (figure 2). Post-treatment counts in the same plot averaged 37.8 fire ants (figure 4) which translate to a 35% reduction in fire ant population (figure 8). Pre-treatment counts in the thornless blackberry plot averaged 19.9 fire ants (figure 2). Post-treatment counts in the same plot averaged 12.15 fire ants (figure 6) which translates to a 39% reduction in fire ant population (figure 8). Pre-treatment counts in the thorned blackberry plot averaged 52.7 fire ants (figure3). Post-treatment counts in the same plot averaged 28 fire ants (figure 7), which translates to a 47% reduction in fire ant population (figure 8). Post-treatment counts across all of the plots averaged 25.98 fire ants, which 40% reduction in population from the total average pre-treatment counts of 43.57 (figure 8).

Conclusions

The use of methoprene on commercial berry patches demonstrated an average 40% reduction in fire ant populations with only one application of the bait. The grower noticed this reduction and was very pleased with the results. Ideally the product should be used again in the fall to reduce overwintering populations. This is especially true in strawberry production because it is a very early crop. Methoprene should prove to be an option for fire ant control for commercial vegetable and berry producers where no option had existed before.

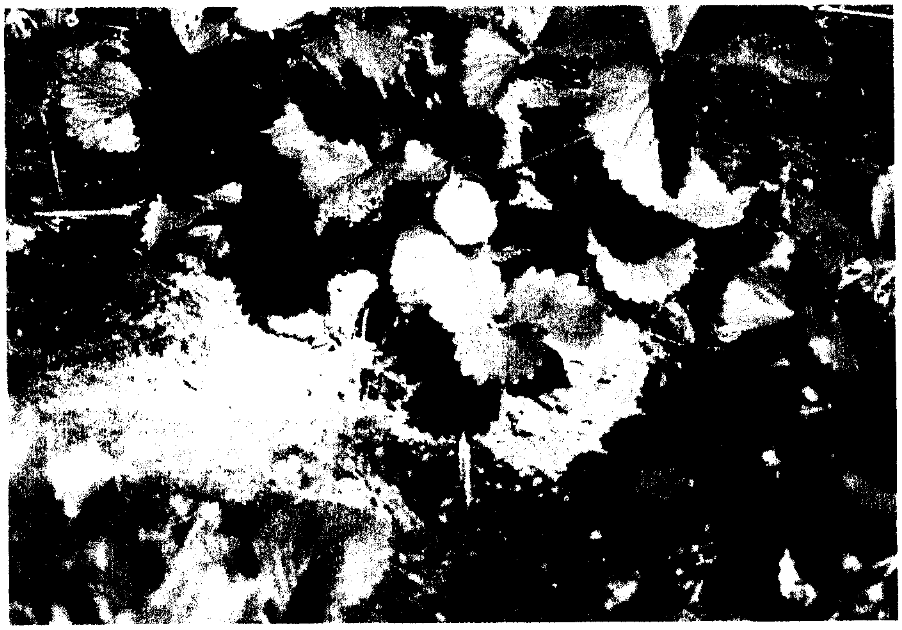


Figure 1: Fire Ant Mound Surrounding Strawberry Plant.

Figure 2: Pre-treatment Counts — Strawberry Plot, Lincoln County, AR 5/20/99.

Trap #	# of ants	Ant ID
1	101	fire ant
2	0	---------
3	139	fire ant
4	141	fire ant
5	2	non-fire ant
6	151	fire ant
7	30	fire ant
8	0	---------
9	10	fire ant
10	140	fire ant
11	0	---------
12	112	fire ant
13	1	non-fire ant
14	135	fire ant
15	46	fire ant
16	20	fire ant
17	0	---------
18	7	non-fire ant
19	0	---------
20	137	fire ant
average fire ant population	58.1	

Figure 3: Pre-treatment Counts — Thornless Blackberry Plot, Lincoln County, AR 5/20/99.

Trap #	# of ants	Ant ID
1	5	non-fire ant
2	5	non-fire ant
3	1	non-fire ant
4	34	fire ant
5	98	fire ant
6	1	fire ant
7	10	fire ant
8	25	fire ant
9	31	fire ant
10	4	non-fire ant
average fire ant population	19.9	

Figure 4: Pre-treatment Counts — Thorned Blackberry Plot, Lincoln County, AR 5/20/99.

trap #	# of ants	ant ID
1	20	fire ant
2	128	non-fire ant
3	112	fire ant
4	141	fire ant
5	2	non-fire ant
6	151	fire ant
7	30	fire ant
8	0	---------
9	10	fire ant
10	140	fire ant
11	0	---------
12	112	fire ant
13	1	non-fire ant
14	135	fire ant
15	46	fire ant
16	20	fire ant
17	0	---------
18	7	non-fire ant
19	0	---------
20	137	fire ant
average fire ant population	52.7	

Figure 5: Post-treatment Counts — Strawberry Plot, Lincoln County, AR 7/13/99.

trap #	# of ants	ant ID
1	70	fire ant
2	0	---------
3	55	fire ant
4	28	fire ant
5	65	non-fire ant
6	170	fire ant
7	41	fire ant
8	0	---------
9	7	fire ant
10	7	fire ant
average fire ant population	37.8	

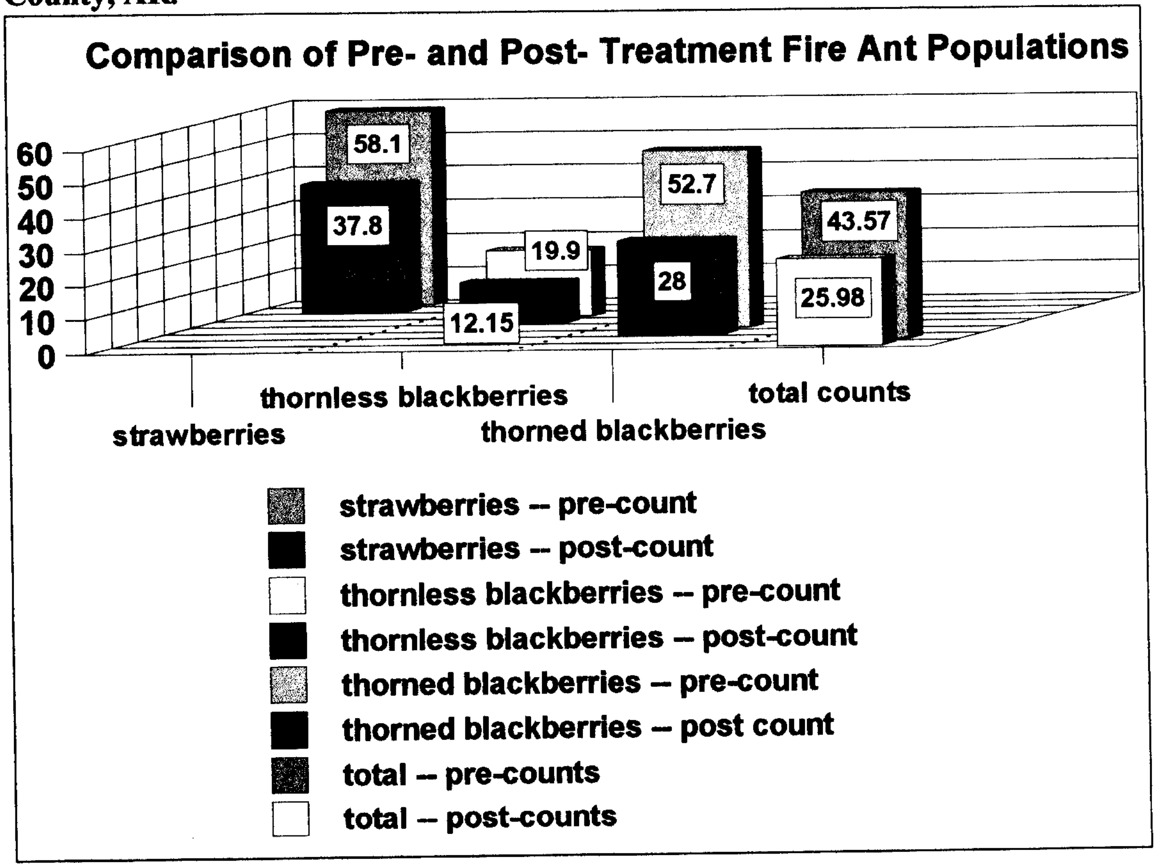
Figure 6: Post-treatment Counts — Thornless Blackberry Plot, Lincoln County, AR 7/13/99.

trap #	# of ants	ant ID
1	18	non-fire ant
2	25	non-fire ant
3	0	non-fire ant
4	0	fire ant
5	14	fire ant
6	0	fire ant
7	80	fire ant
8	28	fire ant
9	7	fire ant
10	0	non-fire ant
11	100	non-fire ant
12	0	---------
13	47	non-fire ant
14	102	fire ant
15	64	non-fire ant
16	5	non-fire ant
17	11	fire ant
18	1	fire ant
19	0	---------
20	110	non-fire ant
average fire ant population	12.15	

Figure 7: Post-treatment Counts — Thorned Blackberry Plot, Lincoln County, AR 7/13/99.

trap #	# of ants	ant ID
1	5	non-fire ant
2	8	non-fire ant
3	0	---------
4	40	fire ant
5	100	fire ant
average fire ant population	28	

Figure 8: Comparison of Pre- and Post- Treatment Fire Ant Populations. Lincoln County, AR.



IMPORTED FIRE ANT CONTROL: HOW FREQUENTLY TO APPLY INSECTICIDES

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Jones et al. (1998a) reported that repeated application of the insecticides Talstar® (bifenthrin), Dursban® (chlorpyrifos), and Amdro® (hydramethylnon) at two month intervals were effective at keeping visible red imported fire ant (IFA), Solenopsis *invicta*, colonies at low levels. Jones et al. (1998a) also suggested that reducing the frequency of insecticide applications might maintain fire ant populations at low levels. Insecticide applications on a three month cycle would likely result in reduced costs to landowners trying to control fire ants and also reduce the amount of insecticides introduced into the environment. Jones et al. (1998b) used these same insecticide tests to demonstrate that mound counts provide a poor estimate of fire ant control. Alternatively, Jones et al. (1998b) suggested using bait stations to assess insecticide efficacy. This paper investigates that suggestion and uses the same experiment to examine how one-, two-, and three-month treatment intervals might affect recovery of ant populations from insecticide treatments.

Materials and Methods

The experiments were conducted on sites at the Monticello and Warren, Arkansas, municipal airports. The sites were divided into six separate blocks of 1.6 ha each. The Monticello site consisted of 4 blocks and the Warren site 2 blocks. Each block was divided into four plots of 0.4 ha (Fig. 1) that were treated with an insecticide or used as a check plot. Each block had at least a 35 m wide buffer between it and the other blocks so that all of the plots inside them were open to re-colonization by fire ants on at least two sides. One of three insecticides, Talstar® (bifenthrin), Dursban® (chlorpynfos), or Amdro® (hydramethylnon), was randomly assigned and applied to 3 of the 4 plots within each block. A fourth plot in each block was left as an untreated check plot.

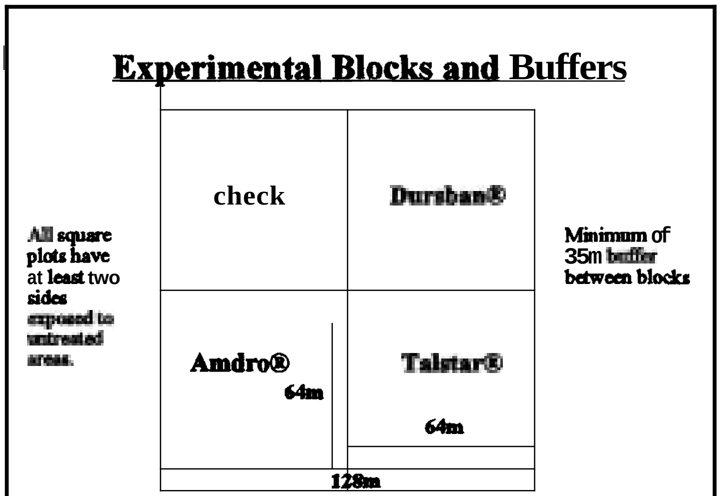

Fig.1 Layout of block with treatment plots.

Liquid insecticides were applied with a portable five-nozzle sprayer mounted on the back of a Polaris 350 all-terrain-vehicle (ATV). Plots treated with Talstar® F (FMC Corporation, Philadelphia, PA) received 1200 ml of flowable per 0.4 ha. Plots treated with Dursban® 4L (DowElanco, Indianapolis IN) received 960 ml per 0.4 ha. Amdro® fire ant bait (American

Cyanamid, Wayne, N J) was applied at approximately 0.7 kg per 0.4 ha. using a Herd Model GT-77 bait spreader mounted on the back of the ATV.

Applications were made in May 1997 and continued at two month intervals until September 1997. Ant populations were measured using bait stations one month after applying the insecticides to investigate a 1-month post-treatment interval. Because of reduced ant activity during the winter months, no applications were made from October 1997 to March 1998. Applications were resumed in April 1998, and the ants were sampled in June to investigate the effects of a 2-month interval between applications. In June it was decided to extend the application interval and ant sampling from 2 to 3 months, therefore, ant populations were not measured until September 1998. This provided the three-month interval between application and population measurements.

At each sampling interval, ants were collected by placing 36 sugar baits, spaced 9 m apart, in the center of each 0.4 ha plot (Fig. 2). A sugar bait consisted of a 1 cm long cotton dental roll saturated with a 10% sugar solution placed in the middle a small plastic vial lid placed on the ground. After one hour the sugar baits and ants were gathered by pressing a vial down on the lid. The ants were taken back to the lab for identification and counting.

Data analyses were conducted on the number of baits occupied in each plot using ONE-WAY ANOVA and Tukey's B means separator (SPSS Inc. 1999). Data were transformed using square roots.

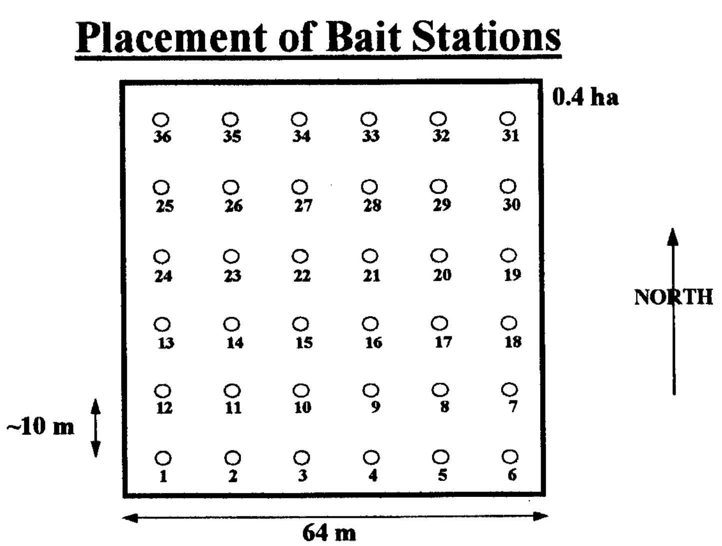

Fig. 2 Bait station placement in each treatment plot.

Results

For the one-month sampling intervals, tests for significance among insecticides showed that Talstar® and Dursban® performed similarly and were significantly lower than check plots (Fig.3). Amdro® performed similar to Dursban® but was not significantly lower than the check plots until the third post-treatment interval (Fig.3).

At the spring treatment in April 1998, after approximately six months without treatment, ant populations in plots that had been treated with Talstar® were significantly lower than all other plots (Fig.3). Dursban® and Amdro® treated plots were not significantly different from each other but were significantly lower than the check plots and higher than the Talstar® plots (Fig.3).

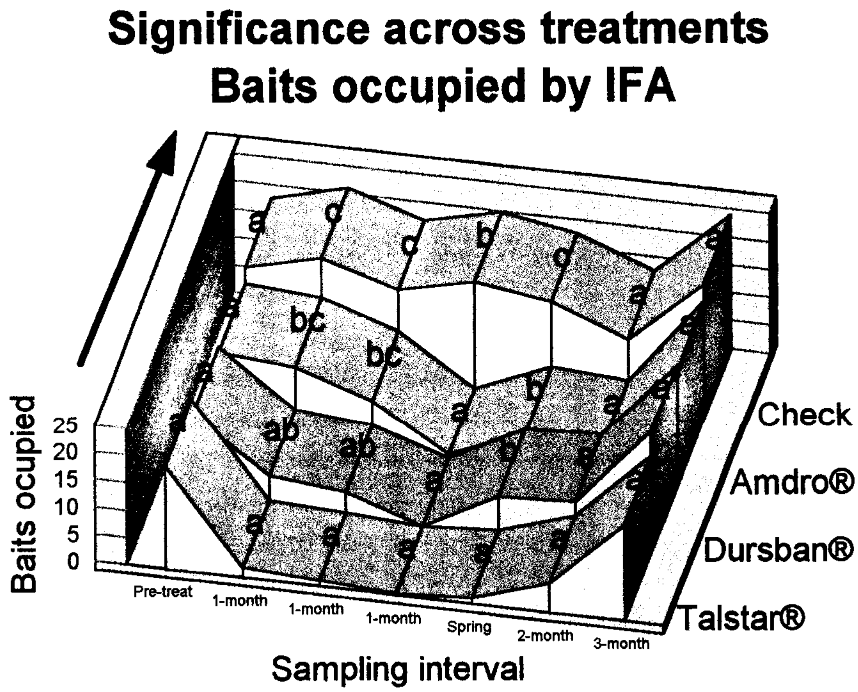

Fig. 3 Significance across treatments of baits occupied by IFA. Means with the same letter within a month are not significantly different at the 0.05 level (Tukey's B).

When population measurements were taken at the 2-month and 3-month sampling intervals there was no significant difference between any of the test plots (Fig.3). At the end of the 3-month sampling interval, populations in all plots had risen near or above the pretreatment levels (Fig.4).

Comparison of individual treatments across sampling intervals showed that ant populations in the Talstar® treated plots dropped off significantly after the first treatment and remained very low throughout the 1-month sampling intervals and into the spring (Fig.4). They did, however, rise when measurements were taken at the 2-month interval, and were significant at the 3-month interval (Fig.4).

Dursban® treated plots showed gradual but significant reductions in ant populations for the 1-month sampling intervals (Fig.4). Ant populations rose significantly when experiments were resumed in the spring and remained unchanged until another significant rise at the 3-month sampling interval (Fig.4).

Populations in the Amdro® treated plots did not show a significant reduction until the third 1-month measurements were taken (Fig.4). Following the winter months, population levels were not significantly different from previous levels in the Amdro® plots (Fig.4). There was no significant change at the 2-two month sampling interval but there was a significant increase during the 3-month interval (Fig.4).

The populations in check plots remained relatively steady throughout the study (Fig.4).

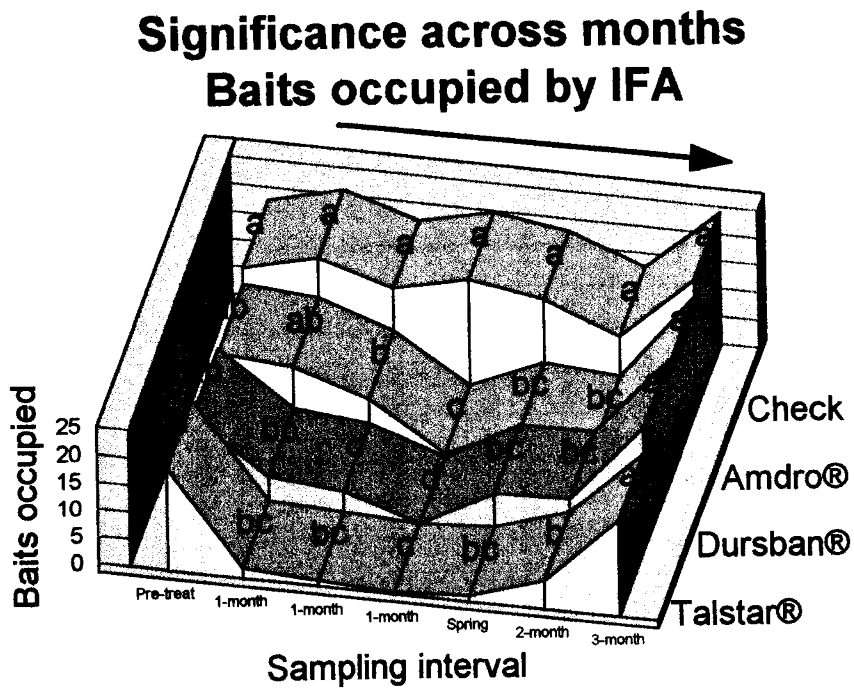

Fig. 4 Significance across months of baits occupied by IFA. Means with the same letter within a month are not significantly different at the 0.05 level (Tukey's B).

Discussion

Talstar® appears to be more effective at reducing and maintaining low ant populations than Amdro® or Dursban® based measurements taken one month after application. Although there was no significant difference between Amdro® and Dursban® in reducing and maintaining low ant populations at the one-month intervals, actual populations in the Dursban® treated plots were lower than in the Amdro® treated plots at the one-month intervals.

Amdro® and Dursban® gradually reduced populations, based on the number of occupied baits, over the entire cycle of one-month sampling until they reached levels similar to Talstar®. The gradual reduction in populations in these plots may be a result of the two-month time interval between applications. If applications had been made on a monthly basis, the populations may have fallen more rapidly. Our data only reflect 1-month, post-treatment populations for insecticide applications made at two-months intervals.

Talstar® also appeared to maintain low levels of ant populations through the winter months, while populations in the Amdro® and Dursban® treatments rose. This may be due to a longer residual time for Talstar®, but could also be due to the extended period of reduction in populations from previous months or a combination of both. Lower residual activity and lack of population reduction over the 1-month sampling intervals may have also contributed to the rise in ant numbers on the Amdro® and Dursban® plots.

Populations on all treated plots did not vary significantly from each other or the check at the 2-month interval, suggesting that two months may be too long an interval between applications. At the 2-month interval, however, numbers in the check plots were at their lowest compared to any other time during the study.

The significant rise in populations on all treated plots at the 3-month sampling interval suggests that three months is simply too long to wait between applications with these insecticides. This rise lends credence to claims of fire ants being better able to re-infest an area after insecticide treatment has stopped, due to lack of competition by native ants (Collins et al. 1992).

Obviously, there are several points at which this study can be improved. To get a more accurate reflection of monthly treatment performance, the 1-month sampling intervals should be scheduled so that applications and treatments run concurrently . The manner in which they were done was due to a concurrent study.

Also, the 2- and 3-month intervals need to be repeated for an extended period of time. Although there were six replicates of each treatment, the study is not able to show conclusively that these treatment schedules will or will not work when carried out over an extended period. Our study does, however, suggest what results may be expected from these intervals when populations are measured using bait-station sampling methods.

Acknowledgments

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MODELING AMDROB APPLICATION SCENARIOS

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Abstract

A dynamic model was used to calculate the number of Amdro® (hydramethylnon) applications per year necessary to maintain red imported fire ant (Solenopsis *invicta)* populations under two given levels of control: 90% and 60% (keeping total colony coverage below 10% and 40%, respectively). The model was applied to data from 437 weather stations within the fire ant's current range in the southern U.S. This dynamic fire ant population model was formulated to describe major aspects of colony life history, including nest founding, brood raiding, colony area growth, alate production, territorial competition with neighbors, queen death and colony death. Colony growth rate depends on daily max/min soil temperatures. The rate of queen influx was determined by the model and a 32x32 m plot was populated with emigrating female alates from surrounding territories. The population on the plot was allowed to grow until the critical threshold of 10% or 40% of the area was infested. Amdro® bait was then applied and colonies were eliminated using a mortality function that increased linearly fiom 0.8 for small colonies to 0.95 for large colonies. To maintain 90% of the area without fire ants, model results indicate that the number of applications per year ranged from four in southern Florida and Texas, to two on the northern limits of the ant's range. To maintain 60% control the number of applications was reduced to two over much of the lower South and one in the upper South. Boundaries for application areas were delineated using spatial analysis procedures within Geographic Information Systems (GIS) software. Maps were then generated to simplify representation of results. Future research will address timing of application intervals.

Introduction

Because of its efficacy and easy of use, Amdro® (hydramethylnon) has been a popular insecticide for fire ant control for some time. When insecticide tests are conducted in Arkansas, Amdro® is typically used as the reference for efficacy. Thompson et al. (1997) showed that when the population model of Kozukhin and Porter (1994) was modified to assess the potential for control of fire ants with Amdro®, large numbers of ants were left to recolonize treated sites during the interval between the standard spring and fall applications. Even when 100% control was applied, the number of ants still present before the second application was 60% of the typical compliment of 17-18 million ants per hectare. This quick resurgence in ant populations is a cause for concern. Subsequently, Korzukhin's model was adjusted to conduct a more detailed assessment of the frequency of applications needed to keep fire ants at low levels. That assessment is reported here.

Fire Ant Model

A brief description of the model is given below. See Kozukhin and Porter (1994), and Korzukhin et al. (submitted) for details.

Individual Colony Model. Colony area (m^2) is the main dynamic variable, while the number of workers in a colony is proportional to the area. Colony alate production in number per day, is an output variable. Colony area dynamics are determined by the production and the death of workers; the rates of these processes depend on soil temperature. Daily max/min air temperature values from U.S. weather stations were converted to max/min soil temperatures to run the model. After reaching reproductive size, a colony splits its growth resources between worker and alate production (Tschinkel 1993). A population of colonies is modeled using the following population model.

Population Model. It is assumed that there is a big ecologically homogeneous territory populated with fire ants, and that our small 32x32 m plot is representative of overall colony population dynamics. The overall territory is considered to be covered by these small plots, with identical colony patterns within each plot; plot borders are penetrable, so fire ant colonies in the central plot can interact with colonies of 8 adjoining plots. Originally, the plot is populated with female alates immigrating from surrounding territories, but when and if colonies within the plot reach a reproductive size, all the alates produced subsequently land within the plot. Colonies grow and develop as described by the algorithm detailed in Kozukhin and Porter (1994). Queen mortality has three components. First, colonies die with a daily probability that depends on colony size and decreases as a colony gets larger. Second, competitive mortality takes place when a small colony is squeezed by its larger neighbors. And, finally, the queen in a colony can die when it reaches old age, at about 6 years. Maximum colony growth rate is based on Markin et al. (1973) measurements of beginning colony growth in a field with temperatures taken from the three nearest meteorological stations. Parameters of the stochastic mortality function were found using Tschinkel's (1992) observations on young colony dynamics.

Model Runs. The model was run for 437 meteorological stations more or less evenly distributed within the southern U.S. For each station, three runs were performed, the first 'initiating run', provided queen influx, and the final colony configuration that was used to initialize the next two runs. For any single Amdro® application, the probability that a colony would find the bait was based on colony area and increased linearly from 0.8 for small colonies to 0.95 for large colonies. The model assumed that affected colonies died immediately. Then, during colony repopulation of the plot, when the total area of colonies exceeded threshold values of 10% or 40%, the bait was reapplied.

Spatial Analysis. Output from the model for each management level was incorporated into a Geographic Information System (GIS) using ArcView® software. Geographic coordinates for each weather station location served to link model predictions to physical locations on the maps. The number of predicted applications necessary to control populations for each site was plotted for each station. Data were spatially analyzed using kriging (Burrough and McDonnell 1998) to create interpolated values for a continuous surface of application areas from the point data. Contour lines were then created to delineate boundaries between treatment areas. Map layouts were produced to illustrate the number of applications necessary to maintain populations at the investigated levels. These visual representations allow easy interpretation of complex model results.

Results

Obviously, keeping ants off 60% of an area is easier than keeping them off 90% of the area. Thus, more treatments are needed to maintain 90% control than 60% control. For the 60% level of control, Figure 1a shows the number of Amdro® treatments computed by the model for each weather station location, and Figure 1b shows the boundary between application areas defined by kriging analysis. Likewise, Figures 2a and 2b show similar information for the 90% control level, except that up to 4 applications are needed. Our experience in southeastern Arkansas, while conducting a demonstration in 1993 and 1994 with more than 60 sites in several counties, showed that the typical spring and fall applications were sometimes inadequate. Many comments from landowners revealed that even though our tests showed few fire ant mounds, they still had problems with ants. This study shows that three applications of Amdro® per year are needed to maintain 90% control in southern Arkansas. If a household can tolerate higher populations of fire ants, the number of applications can be reduced to one. Yet to be determined for each of these Amdro® applications are appropriate timing intervals that will best keep fire ant populations at the desired level. Amdro® timing will be addressed in future research.

Acknowledgments

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EVALUATION OF AMDRO IN COMBINATION WITH SEVERAL RED IMPORTED FIRE ANT (RIFA), *SOLENOPSIS INVICTA* BUREN BAITS AS A BROADCAST APPLICATION

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The objective of this experiment was to determine if blending Amdro with other RIFA baits would increase the overall control when compared to Amdro alone. The pre-treatment population rating and pesticide application were performed on May 21 1999 in Abbeville Co, South Carolina. Three 114-acre subplots were placed within each of 8 one-acre plots with each one-acre plot receiving one of the following broadcast treatments: Award, Amdro, Extinguish, Distance, Amdro +Award, Amdro + Extinguish, Amdro + Distance and an untreated control. The pre-treatment evaluation averaged 9.16 active mounds per subplot. Treatment subplots were evaluated pre-treatment and at 1, 3, 7, 12, 16, and 24 weeks post-treatment. Analysis of variance using Duncan's New Multiple Range Test showed that all pre-treatment plots and control plots were not significantly different and that Amdro + Distance provided the quickest and most long lasting control as well as having the lowest population index for each week evaluated.

EVALUATION OF FIRE ANT BAIT IN ARKANSAS BEEF CATTLE PASTURES

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Abstract

Amdro® Pro and Extinguish™ Fire Ant baits were evaluated against red imported fire ants, Solenopsis invicta, in beef cattle pastures in Clark and Nevada Counties, located in SW Arkansas. Treatments were AmdroQ Pro 1.5 lb/ per acre, Extinguish™ 1.5 lblacre, 0.75lb Amdro® Pro and 0.75 lb Extinguish™ combined, 0.75lb Extinguish™, 0.75 lb Amdro® Pro, and an untreated control plot. Results from mound counts and ant bait stations at 1 and 2 months post treatment demonstrated a marked reduction. A significant reduction in collections from ant bait stations and active mound counts was noted with the 1.5 lb Amdro®, combined (0.75 lb AmdroQ Pro and 0.75 lb Extinguish™), 1.5 lb Extinguish™ and the 0.75 lb AmdroQ Pro treatments.

Introduction

Reported annual losses in Arkansas as a result of the red imported fire ant, *Solenopsis* invicta, have been estimated at $35 million (Jones et.al. 1996). Of these figures, annual losses to the cattle industry are estimated at $1.2 million. These losses include direct losses as well as damage to equipment and control costs. Currently, only two fire ant bait products, AmdroQ Pro and Extinguish™, are labeled for use in pastures grazed by beef cattle. The purpose of this study was two-fold: 1) Evaluate the efficacy of Amdro® Pro (0.73% hydramethylnon, a slow acting toxin) and Extinguish™ (0.5% S-methoprene, an insect growth regulator) against the RIFA and 2) Demonstrate to area cattlemen the options available to efficiently manage fire ant populations on their farms.

Methods and Materials

Amdro® Pro and Extinguish™ fire ant baits were applied to two separate beef cattle pastures in Clark and Nevada Counties, Arkansas. Treatments in the Clark county pasture were: 1.5 lb. AmdroQ Prolacre, 1.5 lb. Extinguish™/acre, 0.75 lb. AmdroQ Pro/acre, 0.75 lb Extinguish™, a combination of 0.75 lb Amdro® Pro and 0.75 lb Extinguish™/acre, and an untreated control. Plot sizes ranged from 250' X 300' to 300' X 300' . Treatments in the Nevada County pasture were: 1.5 lb Amdro® Pro/acre, 1.5 lb Extinguish™/acre, a combination of 0.75lb Amdro® Pro and 0.75 lb Extinguish™/acre and an untreated control. Plot sizes at the Nevada County pasture were 300' X 300'.

Bait applications were made on April 30,1999 and May 19,1999 for the Clark and Nevada County pastures, respectively. Treatments were applied using an Earthway® Even-Spread Canvas Cyclone Seeder No.11415.

Two methods were used to evaluate the presence of the RIFA. An estimate of the number of active RIFA mounds per acre was made by counting the number of mounds in a ca. 1/4 acre circle created using a 59 foot rope tethered at the center of the circle (Figure 1). Mounds were considered active if ants responded within 20 seconds of probing the mound with an 1/8 inch metal probe. Four mound per acre estimates were made in each plot. Averages for each plot were then multiplied by 4 to convert to mounds per acre. Pre and post treatments counts were made on April 30 and June 17, 1999, respectively, for the Clark County study.

Figure 1. One-quarter acre rope technique used to determine mound density.

The second method of evaluation was an estimate of the number of foraging ants collected from baited vial lids. Four transects ca. 60 feet apart consisting of 6 bait station at 40 foot intervals were used in each plot. The bait stations consisted of the plastic snap cap from a 7 dram vial baited with a 1/4 X 1/4 X 1/4 piece of a hot dog wiener (Figure 2). Bait station locations were marked with 2' fluorescent flags. Counts were taken ca. 30 minutes after the stations were placed into the plot. The number of ants counted on each of the 24 bait station were averaged to figure the overall mean number of ants collected from each plot. Pre and post-treatment counts were taken. Evaluation dates were April 30 and June 17, 1999, and May 19, June 2, and July 26, 1999 for Clark and Nevada Counties, respectively.

Figure 2. Bait stations used to collect foraging RIFA's.

Results

Results from the Clark Co. site indicated a significant RIFA population reduction at 48 days post-treatment on plots treated with Amdro® Pro, the Amdro® Pro/Extinguish™ combination and the half Amdro® Pro rate (Figures 3 and 4). Foraging ant data demonstrated a percent control from these treatments ranging from about 96 to 82%. Only slight population reductions were noted with either of the Extinguish™ rates. Averages from mound counts and foraging ants demonstrated very similar trends.

Figure 3. Mean number of RIFA mounds per acre in Clark Co. pasture treatments.

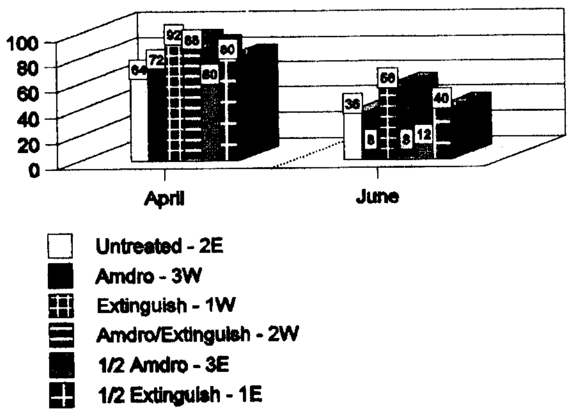
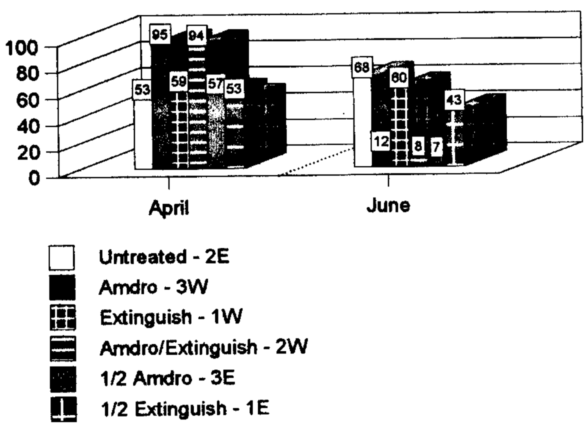
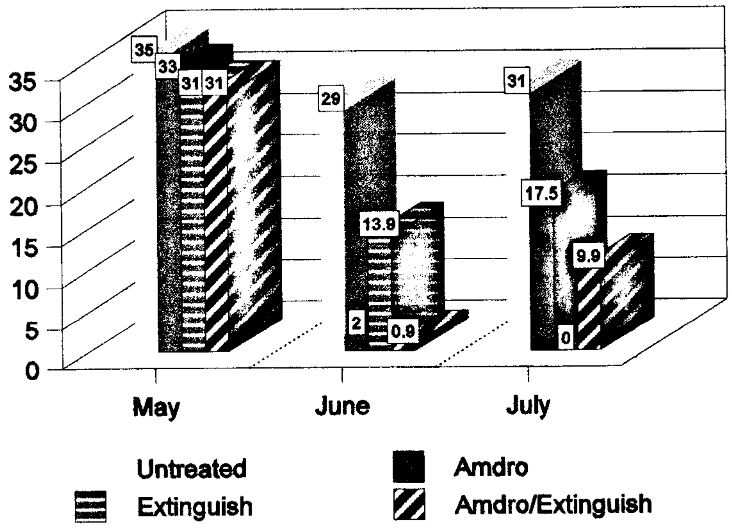


Figure 4. Mean number of Foraging RIFA in Clark Co. pasture treatments.



Foraging ant results from the Nevada Co. site at 14 days post-treatment demonstrated significant RIFA population reductions with Amdro® Pro and the Amdro® Pro/Extinguish™ combination (Figure 5). Percent reductions were 97, 94 and 53% for the Amdro® Pro/Extinguish™ combination, Amdro® Pro, and Extinguish™ treatments, respectively. However, by 68 days post-treatment the populations in the Amdro® Pro and Amdro® Pro/Extinguish™ combination rebounded to 56 and 31% control, respectively. Conversely, over 99% percent control was achieved from the Extinguish™ treated plot at 68 days post-treatment.

Figure 5. Mean number of Foraging RIFA in Nevada Co. pasture treatments.



Discussion

Although results varied between pasture sites, they demonstrated that both bait products carrying pasture labels can be used to efficiently manage RIFA populations. Fire ant density and cultural practices may account for some of these differences.

These studies were very successful in demonstrating RIFA management options available to beef cattle producers. Both resulted in numerous calls to county extension faculty regarding fire ants and have helped cattleman make sound decisions. This has given cattlemen an idea of what products to use depending upon the urgency for desired control and how to prioritize the areas where treatments are necessary.

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RED IMPORTED FIRE ANT (RIFA) FORAGING ON DIFFERENT BAIT FORMULATIONS

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Introduction

Various baits such as tuna, peanut oil, potato chips and sugar water have been used in red imported fire ant (RIFA) foraging studies. Previous work has found food preference is based on length of time a bait is available and season (Ali *et al.* 1986; Stein et *al.* 1990). Simultaneous comparison of different baits is currently unavailable, making it difficult to compare individual studies conducted with different baits.

We compared the efficacy of different baits commonly used to study RIFA foraging behavior, Understanding the performance of each bait will allow studies of foraging activity to be more accurately compared with one another.

Objectives

1. Document the relative efficacy of different bait formulations in measuring foraging activity of RIFA
2. Identify seasonal effects on efficacy of different baits.

Materials and Methods

Studies were conducted in Clemson, SC in the summer and fall of 1999 on two pastures and one managed turfgrass site. Baits were placed in 47-mm clear petri dishes lined with absorbent paper in the following quantities: MSAA with peanut oil (2ml), hot dogs (2g), peanut butter (2 g), potato chips (2 g), and tuna (2 g).

Baits were placed in a 5x5 Latin square design (25 m^2 grid) to randomize their position. Baits were placed out for 30 minutes before recollecting and were returned to the laboratory for identification and counting. Mounds within the plots were counted, marked, and measured. Soil temperature and moisture were measured at two randomly selected points throughout the plot. The amount of foraging activity at each of the different types of baits was analyzed using a general linear model.

Results

No significant differences were found in mean number of foragers collected between baits during summer ($p = 0.093$) or fall ($p = 0.510$) (fig. 1). Significant differences in the number of foragers collected were detected between sites in summer ($p = 0.014$) and summer and fall combined ($p = 0.016$), but not in fall ($p = 0.545$). The number of foragers collected from one pasture site was significantly different than the managed turfgrass site ($p = 0.027$) and the other pasture site ($p = 0.0032$) in the summer. There was also a significant difference in the number of foragers collected between summer and fall seasons ($p < 0.001$).

Mean Number of Foraging Ants Collected on Various Baits over Season

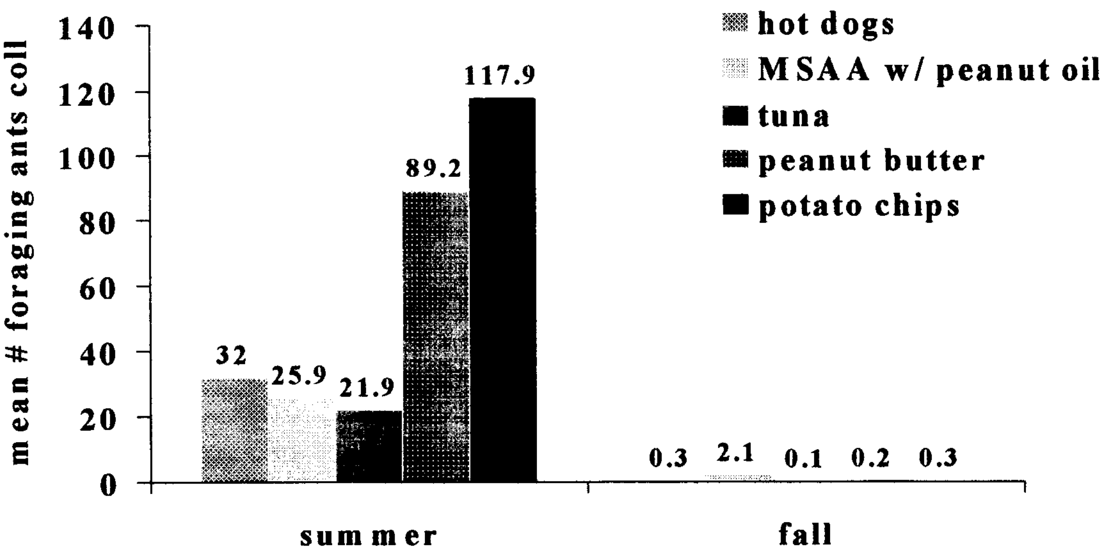

Fig. 1 Ants foraging on each bait type in summer and fall samples.

Discussion

Results from summer and fall suggest all five baits are equally attractive within a season. Seasonal differences are to be expected due to temperature differences and are reflected in lower mean foraging numbers. Foraging differences among sites during summer samples might be due to a difference in mound numbers among the sites. A spring sample is planned for April 2000.

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TAST-E-BAIT™: A POTENTIAL ALTERNATIVE TO PREGELLED CORN

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Introduction:

At the current time most commercial fire ant baits are formulated on the same inert carrier. This carrier is a corn based product known as pregelled corn and is produced by a sole source (Illinois Cereals Mills, Paris, IL). If for any reason that source is eliminated, alternate bait carriers are not available. The first successful bait toxicant for use against fire ants was mirex, which was formulated with corn cob grit as the inert carrier (Lofgren et al. 1963). Banks et al. (1981) reported that efficacy of hydramethylnon baits formulated on an extruded corn pellet carrier was superior to baits formulated with corncob grit carrier. Superior performance of hydramethylnon formulated on the more friable and absorbent extruded corn pellets led to registration of Amdro® in 1980. Almost all other baits that have been commercialized are formulated on the pregelled corn carrier.

Tast-E-Bait (Advanced Organics, Upper Sandusky, OH) is under development as a potential alternative carrier for use with various active ingredients. Tast-E-Bait is derived from bakery waste and contains ca. 11.3% protein, 10.4% fat, and 62.7% sugars and starches (Source: Advanced Organics). We compared several characteristics of both bait carriers in a series of laboratory and field trials.

Materials and Methods:

Determination of physical characteristics - Standard laboratory procedures were used to determine several physical characteristics of both carriers including bulk density, angle of repose, flow rate, swath width, etc.

Laboratory bait accevtance trials - Four Tast-E-Bait formulations were tested for bait acceptance. Field collected RIFA colonies in 12 liter plastic pails were brought into the laboratory and allowed to acclimate for one week prior to testing. On November 8, 1999 colonies were provided a Tast-E-Bait formulation (candidate) and a standard bait comprised of pregelled corn containing 20% soybean oil. Four grams of each bait were offered to five colonies (replicates) for 24 hours at which time any remaining bait was removed from the colony, weighed, and an acceptance ratio computed. The acceptance ratio was computed by dividing the grams of candidate bait removed by the grams of standard bait removed.

Laboratory efficacy tests - Efficacy of hydramethylnon and fipronil baits against field collected RIFA colonies was determined in the laboratory. Field collected RIFA colonies were shoveled into plastic pans (11" x 13"), returned to the laboratory and allowed to acclimate for one week prior to testing. Test colonies were provided four grams of the following bait formulations: standard commercial Amdro (0.73% ai, lot number 927801E), Tast-E-Bait formulated with hydramethylnon at 0.73% ai, (lot number AC 11998-152), fipronil on pregelled corn (1.5 ppm ai, lot number 15stgx41), fipronil on Tast-E-Bait (1.5 ppm ai, lot number 17stgx122-2), pregelled corn containing 20% soybean oil with no toxicant, Tast-E-Bait containing 10% soybean oil with no toxicant, and untreated controls. This test was initiated on February 22, 2000, and there were four replicates per treatment. The colonies were allowed to feed on the different baits for 24 hours at which time any remaining bait was removed and weighed to determine the amount consumed. Following treatment colonies were watered as needed, and provided freshly killed crickets for food. Observations including relative size of "bone piles", food consumption, and general colony maintenance were made weekly for the duration of the 12 week trial or until mortality occurred.

Results:

Physical characteristics - Results are summarized in Table 1.

Table 1. Some physical characteristics of Tast-E-Bait vs. Pregelled Corn (containing 20% soybean oil)

Characteristic	Tast-E-Bait	Pregelled Corn
Bulk Density (lb/ft)[1]	30	15
Angle of repose	ca. 50°	ca. 50°
Flow rate[2]	13.4	12.7
Overall swath width[3]	25 ft	25 ft
No. particles/sq. ft[1]	14.56	9.59
Compatibility with a Herd® GT-77 Granular Applicator[4]	Good	Good
Estimated Cost/lb (¢)	30[5]	27.5[6]

[1] Applied at a rate of 1.5 lbs bait/acre
[2] Gm/sec. through a 0.5" diameter funnel
[3] Based on a Herd GT-77 granular applicator
[4] Imperative that blocking plate (part No 517R) be installed for application of either bait
[5] FOB Ohio (contains 10% soybean oil)
[6] FOB Illinois (plus soybean oil which cost ¢30 per pound)

Laboratory bait acceptance trials - Results of the laboratory bait acceptance test are shown in Table 2. Acceptance ratios >1.0 indicate that the candidate is more acceptable than the standard. Ratios <1.0 indicates that the candidate is not as attractive as the standard. A ratio of 1.0 means that the candidate bait and the standard bait are equally attractive to foraging workers. All of the four Tast-E-Bait formulations tested were equal to or more acceptable than the pregelled corn standard.

Table 2. Laboratory bait acceptance test with four Tast-E-Bait formulations.

Tast-E-Bait Formulation	Formulation Code	Mean Accetance Ratio ($\pm$ Std. Deviation)
10% soybean oil	0N	1.0 ± 0.11
15% soybean oil	2N	1.2 ± 0.39
12% soybean oil + 1% coca	3N	1.0 ± 0
15% soybean oil + 2% coca	1N	1.4 ± 0.53

Laboratory efficacy tests - The amount of each bait consumed is shown in Table 3. The trial is in progress at this time, so mortality data is not available.

Table 3. Consumption and subsequent mortality of field collected RIFA colonies fed various bait formulations.

Bait formulation	Mean amt. consumed ($\pm$ std. dev.)	Colony Mortality
Standard Amdro	3.4 ± 0.5	Test in progress
hydramethylnon on Tast-E-Bait	2.9 ± 1.2	" "
fipronil on pregelled corn	3.7 ± 0.3	" "
fipronil on Tast-E-Bait	4.0 ± 0	" "
pregelled corn, 20% soybean oil, no toxicant	4.0 ± 0	" "
Tast-E-Bait, 10% soybean oil, no toxicant	3.8 ± 0.3	" "

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FORAGING BEHAVIOR IN *SOLENOPSIS INVICTA*: WHAT *ARE* THE POSSIBLE NEUROHORMONAL MEDIATORS?

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Keywords: Octopamine, Foraging behavior, Neurohormone

The intensity of the foraging activity in fire ant colonies is related to the proportion of workers that are involved in this task and depends on the environmental conditions as well as on the internal state of the society (age and size, composition in larvae and sexuals…). However, little is known on the physiological mechanisms that control foraging behavior at the individual level: What chemicals (neurohormones) mediate the shift from intranidal tasks to foraging actvity outside the nest?

Several lines of evidence indicate that octopamine, a multipotent neurohormone and neurotransmitter of invertebrates, mediates feeding behavior in solitary insects. Indeed, the administrations of octopamine or of its agonists induce a decrease of alimentation.
Based on these data we submit colonies to sub-lethal concentrations of octopamine and of its agonist Chlordymeform (respectively 0.1 to 10 $g.L^{-1}$ and 10^{-4} to 10^{-2} $g.L^{-1}$) to clarify the possible role of octopamine on the control of foraging activity in *Solenopsis invicta.*
We also use HPLC-ECD to quantify brain biogenic amines level (including octopamine) under different feeding conditions.

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